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Towards a broader understanding of the role of personality traits on medical education outcomes

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“**Tenta de novo,**
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Fracassa melhor.”

Samuel Beckett

LIST OF PUBLICATIONS

Ao abrigo do artigo 8° do Decreto-Lei n.o 388/70, fazem parte desta dissertação as seguintes publicações:

This thesis is based on the following publications, which are referred to in the text by their Roman numerals I-V:

I. Lourinho I, Ferreira MA, Severo M. Self-report personality tests and medical school selection. Psicologia: Reflexão e Crítica. 2016; 29(1):48.

II. Lourinho I, Moreira A, Mota-Cardoso R, Severo M, Ferreira MA. Associations between the big five personality traits and a medical school admission interview. Acta Médica Portuguesa. 2016; 12.

III. Lourinho I, Severo M. Are Personality traits really weak/moderate predictors of empathy? Med Teach. 2013; 35(7):6-11.

IV. Lourinho I, Loureiro E, Ferreira MA, Severo M. Self-concept and obsessive-compulsiveness as moderators of anxiety and depression: a Portuguese prospective study. Porto Biomedical Journal. 2016; 1:36-9.

V. Lourinho I, Ferreira MA, Severo M. (2017). Personality and achievement along medical training: Evidence from a cross-lagged analysis. PLoS ONE 12(10): e0185860. https://doi.org/ 10.1371/journal.pone.0185860.

LIST OF ABBREVIATIONS

FFM – Five Factor Model

FMUP - Faculty of Medicine of University of Porto

GEM - Graduate entry medicine

HADS- Hospital Anxiety and Depression Scale

IRI – Interpersonal Reactivity Index

MMI – Mini-multiple interview

MOCI- The Maudlsley Obsessive-Compulsive Inventory

NEO-FFI – NEO Five Factor Inventory

NEO-PI-R - NEO Personality Inventory

OCEAN – Openness to Experience; Conscientiousness; Extraversion; Agreeableness; Neuroticism traits

SITJ – Situational Judgement tests

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ABSTRACT

Personality traits have become popular due their association with significant life outcomes. More recently, medical education researchers have also become aware of their importance, with some authors arguing that personality assessment should be incorporated in the selection of medical students. In fact, selection is commonly accepted as the first step in developing the future health workforce.

In the last years, there has been a worldwide concern with widening the access to medical education. Broadening requirements in relation to non-academic personal characteristics can be considered as one strategy. A second, complementary approach, is to broaden the applicant pool beyond school-leavers. In Portugal, the graduate approach initiated in the academic year of 2007/2008.

This research thesis aimed to contribute to a more extensive understanding of the role of personality traits on medical education outcomes. To achieve that, two general objectives were determined: a) to evaluate the implications of using explicit and implicit measures of personality in the selection of medical students; b) to study the association between personality traits and academic and non-academic outcomes along the medical course. Research was held at the Faculty of Medicine of University of Porto. Participants consisted in three cohorts of medical students (school-leavers and graduates) admitted in the academic years of 2011, 2012 and 2013 who voluntarily completed a large battery of psychometric tests. All of the questionnaires were previously validated in the Portuguese population, thus facilitating future comparisons. Cross-sectional, longitudinal and cross-lagged analysis were performed.

Results showed that the use of different selection tools should be privileged instead of only one tool when choosing medical students. This option may ensure a greater psychological diversity and society's representability, which is in line with the global movement of widening access to medical education. The use of explicit or implicit measures of personality in the selection of medical students was associated with which personality traits we aim to select. However, further research on implicit measures is still needed, to ensure rigorous personality

assessment, less susceptible to faking. We were also able to demonstrate a bidirectional association between personality traits and medical education academic and non-academic outcomes. Empathy, psychological distress (anxiety and depression) and medical academic achievement were linked to personality traits. Moreover, an association between the neuroticism trait and academic achievement was found. This result contributed to the demystification of the idea that some traits are better than others by showing that even the so called “bad trait” (neuroticism) has a bright side. In addition, having simultaneously school-leavers and graduates allowed us to confirm the psychological diversity brought by the latter to medical schools. Nevertheless, the blurring of the initial differences between these two populations along the medical course suggests an influence of the medical school environment on personality traits change. As such, we could put into question the strategies of broadening admission requirements in relation to non-academic personal characteristics and the graduate entry medicine approach. It seems that, apart from the selection single moment, education and training may be powerful implements in promoting effective change. This may be good news because there are several opportunities to design and implement targeted interventions (along the medical course) besides the selection single moment. Also, it is possible that graduates could benefit from having a specific curriculum taking into account their specificities, instead of sharing the same of school-leavers. Either way, we believe that personality assessment may be a useful tool by allowing at least the identification of those who will benefit the most from addressed interventions. It may be necessary to regard personality change and management as a part of medical education as well as selection. Future research on the impact of personality interventions in the medical school environment is required.

RESUMO

Os traços de personalidade têm ganho popularidade pelo facto de se associarem a *outcomes* de vida significativos. Mais recentemente, os investigadores em educação médica também se aperceberam da sua importância, com alguns autores a sugerirem, inclusivamente, que a avaliação da personalidade deveria ser incorporada nos processos de seleção de estudantes de medicina. De facto, a seleção é tida como o primeiro passo em garantir a qualidade dos futuros médicos.

Nos últimos anos, tem-se assistido a um movimento no sentido de aumentar e diversificar a população que ingressa nos cursos de medicina. Uma das estratégias é estender os critérios de seriação a caraterísticas que não sejam exclusivamente académicas. Uma segunda estratégia complementar, foi permitir que outros candidatos já licenciados, possam também concorrer para além dos estudantes que acabam de terminar o ensino secundário. Em Portugal, o contingente especial de acesso ao curso de medicina por titulares do grau de licenciado teve início no ano académico de 2007/2008.

Esta tese de doutoramento pretende contribuir para aprofundar o conhecimento acerca do papel dos traços de personalidade em *outcomes* na área da educação médica. Neste contexto, dois estudos principais foram desenvolvidos: a) Avaliar as implicações de usar medidas explícitas e implícitas de avaliação da personalidade no âmbito da seleção de estudantes de medicina; b) Estudar a associação entre traços de personalidade e *outcomes* académicos e não académicos durante o curso de medicina. A investigação foi realizada na Faculdade de Medicina da Universidade do Porto. A amostra foi constituída por 3 coortes de estudantes de medicina da FMUP que ingressaram via contingente geral de acesso e licenciados que ingressaram através do contingente especial para titulares do grau de licenciado, admitidos entre os anos académicos de 2011 e 2013. Os participantes aceitaram de forma voluntária responder a uma bateria de testes psicométricos, previamente validados para a população portuguesa de modo a facilitar futuras comparações. Foram realizadas análises transversais, longitudinais e também *cross-lagged*.

Os resultados mostraram que a seleção de estudantes de medicina deveria privilegiar a utilização de mais do que um instrumento de seleção. Desta forma, aumenta-se quer a probabilidade de garantir maior diversidade dos candidatos admitidos quer a representatividade da sociedade nos cursos de medicina, assegurando-se o objetivo preconizado pelo movimento de diversificar o acesso ao curso de medicina. A utilização de medidas de avaliação da personalidade explícitas ou implícitas encontra-se associada com os traços de personalidade que queiramos selecionar. Todavia, é necessário investigar outros métodos mais rigorosos e menos suscetíveis a que os candidatos dissimulem características. Os resultados mostraram também uma relação bidirecional entre os traços de personalidade e os *outcomes* académicos e não-académicos. Verificou-se que a empatia, o *distress* psicológico (ansiedade e depressão) e o sucesso académico em medicina estavam associados com os traços de personalidade. Além do mais, a associação encontrada entre o traço de neuroticismo e o sucesso académico em medicina, contribuiu também para a desmistificação de que existem traços de personalidade "melhores" do que outros, ao mostrar que mesmo os traços tidos como "negativos" também podem ter um lado positivo. A nossa amostra, constituída por jovens do ensino secundário e licenciados, permitiu ainda confirmar a diversidade psicológica que os estudantes mais velhos trazem ao curso de medicina. No entanto, a diminuição das diferenças significativas que se verificaram no início do curso entre estas duas populações sugere uma influência do ambiente do contexto da escola médica na mudança dos traços de personalidade. Neste contexto, poderíamos questionar a pertinência das estratégias de estender os critérios de seriação a características não exclusivamente académicas, assim como a legislação de um contingente especial para licenciados. Todavia, os resultados também mostraram que, para além do momento (único) de seleção, a educação e formação ao longo do curso podem ser instrumentos poderosos na promoção de mudança efetiva nos traços de personalidade. Este resultado poderá constituir uma oportunidade, dado que poderão existir vários momentos para desenhar e implementar intervenções especificamente dirigidas. Também poderia ser vantajoso que os licenciados frequentassem um curso de medicina com um currículo específico, e não o mesmo que é frequentado pelos jovens que terminaram o ensino secundário no sentido de preservar e otimizar as suas diferenças. De todo o modo, defendemos

que a avaliação da personalidade poderá constituir um instrumento muito útil por permitir, pelo menos, identificar aqueles que mais beneficiarão de estratégias de intervenção. Parece ser necessário abordar a gestão da mudança na personalidade como parte integrante da educação médica e da seleção dos estudantes de medicina. Investigações futuras deveriam explorar o impacto das intervenções no âmbito da personalidade em contexto de escolas médicas.

OUTLINE OF THE THESIS

The present dissertation is divided into chapters, which include the different manuscripts published in international peer reviewed journals.

Chapter I corresponds to the introduction section. This chapter presents the most important facts published in the last years related to the present work. It constitutes a theoretical background to support the understanding and the future discussion of the information presented in the following chapters.

Chapter II refers to the aims of this research thesis which have resulted in five publications.

Chapter III includes the first paper published in an international peer reviewed journal. It describes, for the first time, the applicant's faking behaviour in responding to personality self-report tests in order to be admitted at a medical school.

Chapter IV includes the second paper published in an international peer reviewed journal. It describes, for the first time, the association between a medical school admission interview and personality traits in accordance with the Five factor model.

Chapter V includes the third paper, published in an international peer reviewed journal. It describes the association between personality traits and empathy in medical students.

Chapter VI includes the fourth paper, published in an international peer reviewed journal. It describes the prevalence of anxiety and depression in medical students, showing its association with personal constructs such as self-concept and obsessiveness-compulsiveness.

Chapter VII includes the fifth paper, published in an international peer reviewed journal. The cross-lagged design allowed us to observe that some degree of neuroticism may enhance medical academic achievement. Furthermore, it suggests a reasonable possibility of personality traits changing along the medical course.

Chapter VIII includes a global discussion of the different studies presented in the previous chapters.

Chapter IX presents the general conclusions of this dissertation and describes the future perspectives aiming to establish, based on the current findings, new research topics for a more comprehensive study.

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CHAPTER I
Introduction

1. Medical education today

This is a time of unprecedented change in medical education. The onrush and intermixing of technology, globalization, teamwork and temporary work have created a complex modern-day workplace. As a result, predicting medicine's future is to enter a hive of competing possibilities: super-specialisation, molecular medicine, technical advances in diagnosis and treatment, evidence-based everything (1). In addition, a radical change in the doctor-patient relationship has occurred, with patients expecting more from their doctors than ever before. Clinicians must also present leadership and management skills and be able to adapt to a setting that increasingly respects other health professionals. In sum, tomorrow's doctors are required to express specific skills and personal characteristics besides being well-qualified and competent technicians (2). These newly emerging society requirements pose challenges to medical schools, which must struggle to fit all the addressing needs. In other words, they shall select who is likely to be successful in medical training and ultimately become competent clinicians (3).This paradigm shift in academic medicine has had effects in the selection of medical students, which is the first step in developing the future health workforce (2).

2. Selection of medical students

The discussion on how to select the most suitable students is one of the oldest issues under debate in medical education, but the most effective assessment still remains an unresolved challenge (4). In many countries, doctors enjoy privileged status, and careers in medicine are satisfying and financially rewarding. Attrition rates in health professional courses are usually low and, once selected, most entrants graduate (2). These may be some of the reasons that explain that, worldwide, demand for medical school places generally far outweighs the available places (5). Thereby, it is crucial that medical schools provide selection processes that are credible, fair, valid, reliable and, above all, publicly defensible (2). With more applicants in the pool, selection processes have relied more heavily on quantifiable data. For many years, medical students' selection used school-leavers' marks as the predominant criteria for entry to medical school (4). In fact, previous achievement has been shown to be important for progression

through medical school and beyond, such that applicants who were admitted on the basis of their previous achievement had lower levels of dropout than those who were not (6). However, so many applicants achieve such high classifications that it is almost impractical to select for medical school primarily on such achievement. In addition, it cannot be assumed that those with high academic ability alone can be turned into competent doctors via medical training, as personal characteristics may need to be present from the beginning (7). Recently, some authors have synthetized the available selection tools on the following: 1) aptitude tests; 2) academic records; 3) personal statements; 4) references; 5) situational judgment tests (SJTs); 6) personality and emotional intelligence assessments; 7) interviews and multi mini-interviews (MMIs) and 8) selection centres (SCs) (3).

In the last decade, beyond a proliferation of medical selection tools, we have witnessed an important movement of widening access to medical education. At least two general strategies can be identified in the bid to widen access to medical education. One is to broaden admission requirements in relation to non-academic personal characteristics. A second, complementary approach, mainly driven by socio-political concerns, is to broaden the applicant pool beyond school-leavers (8).

2.1. Personality assessment and medical education

There has been increased recognition of the importance of using non-academic characteristics, including personality, for performance and for good medical practice. Some authors have identified up to 87 different personal qualities as relevant to the practice of medicine (9) and the inclusion of personality and emotional intelligence as medical selection tools has been under debate (10, 11). Personality assessment has been widely used in personnel selection mainly due to its reputation in predicting and explaining behaviours at work (12, 13). Besides individual performance in different occupational settings, it has been evidenced that personality influences a broad range of individual life outcomes such as happiness, physical and psychological health or even interpersonal outcomes such as peer and family relationships (14-16).

Over the two last decades, personality researchers have agreed generally on a descriptive model of personality traits commonly referred to as the ‘‘*Big Five’’* or the five-factor model (FFM). FFM organizes personality around five broad traits of personality, known by the acronym OCEAN: openness to experience, conscientiousness, extraversion, agreeableness, neuroticism (or emotional stability which is the opposite of neuroticism) and their more specific facets (17). Personality traits are typically defined as descriptions of people in terms of relatively stable patterns of behaviour, thoughts and emotions (18). However, there has been an assumption that some traits are “good” and others are “bad”(19, 20). For example, if conscientiousness has been suggested to be the most consistent trait in predicting good work outcomes across different settings and academic achievement, neuroticism has been linked to psychopathology (21). The factors and descriptive traits for each are provided in Table 1.

Table 1. Construct description of the Five-Factor Model of Personality.

Construct Description	**The extent to which individuals tend to be . . .**
Openness to Experience	curious, intellectual, imaginative, creative, innovative, and flexible (vs. closed-minded, shallow, and simple)
Conscientiousness	organized, responsible, dependable, neat, efficient, and achievement-oriented (vs. disorganized, lazy, irresponsible, careless, and sloppy)
Extraversion	sociable, talkative, optimistic, ambitious, assertive, reward-seeking, outgoing, and energetic (vs. introverted, shy, reserved, quiet, and unadventurous)
Agreeableness	helpful, good-natured, cooperative, sympathetic, trusting, and forgiving (vs. rude, selfish, hostile, uncooperative, and unkind)
Neuroticism	neurotic, nervous, insecure, fearful, and anxious (vs calm, self-confident, stable, resilient, and well-adjusted)

Adapted from MacCrae and Oliver (1992).

The most frequently used instrument for the measurement of the five factors of Personality is the NEO Personality Inventory (NEO-PI-R). This instrument, developed by Costa and McCrae (1992) is the first published instrument designed specifically to measure the big five factors of personality (22). The original inventory was developed to measure the three factors of Neuroticism, Extraversion and Openness, hence named NEO Personality Inventory (PI) which was revised (NEO-PI-R) to include two additional factors of the FFM (Agreeableness and Conscientiousness). The revised self-report form of this instrument consists of 240 items answered on a five-point scale, measuring not

only the big five personality factors (48 items per factor) but also six personality facets within each factor (eight items per facet). A shorter version of this instrument (NEO-FFI, 60-item) is also available for measuring the big five factors without detailed measurement of the facets within each factor (22). Other personality instruments, such as the Zuckerman-Kuhlman Personality Questionnaire (ZKPQ), were also developed to measure the big five factors or some variant of the FFM (23). Although its use in medical education research is not yet widespread, its potential for providing useful information for personality research in medical education is worthy of consideration.

Most of the research undertaken in medical education under the FFM model has focused on academic and professional performance. Overall, the results of the FFM in medical education research generally suggest that, among all big five factors, the conscientiousness trait seems to be a more consistent predictor of academic performance in medical school, and Extraversion appears to be linked to preferences in some ‘‘people-oriented’’ specialties that require more intense patient-doctor interaction (21). Some studies have reported that the conscientiousness trait was predictive of medical school performance, and offered incremental validity over academic performance (10). Consequently, for some authors, personality traits, in particular, conscientiousness, needs to be considered and integrated into selection procedures. However, this finding has been replicated and it was added that conscientiousness was positively related to clinical performance, but negatively related to clinical grades (20).

The association between personality traits and distress has also been established. In a longitudinal study, stress, burnout and satisfaction correlated with trait measures of personality taken five years earlier (24). Doctors who were most stressed showed higher levels of neuroticism, both currently and previously, and those reporting greater emotional exhaustion also had higher neuroticism levels, as well as being more introvert. High levels of depersonalisation related to lower levels of agreeableness. A greater sense of personal accomplishment related to previous deep approaches to study and learning, as well as to being more extravert. Overall satisfaction with medicine as a career related to lower levels of neuroticism. Nevertheless, most of the personality research in medical education, besides being cross-sectional, was conducted based on the premise that traits are causal and immutable (19). Figure 1 aims to demonstrate the

conceptualization of personality traits in medical education at the beginning of this doctoral thesis. As we may observe personality traits were merely assessed indirectly through implicit assessement of medical selection processes. Regarding to medical outcomes the association occcurs in a linear, causal way. Furthermore, its action seems to have more consequences on non-academic outcomes than on academic outcomes.

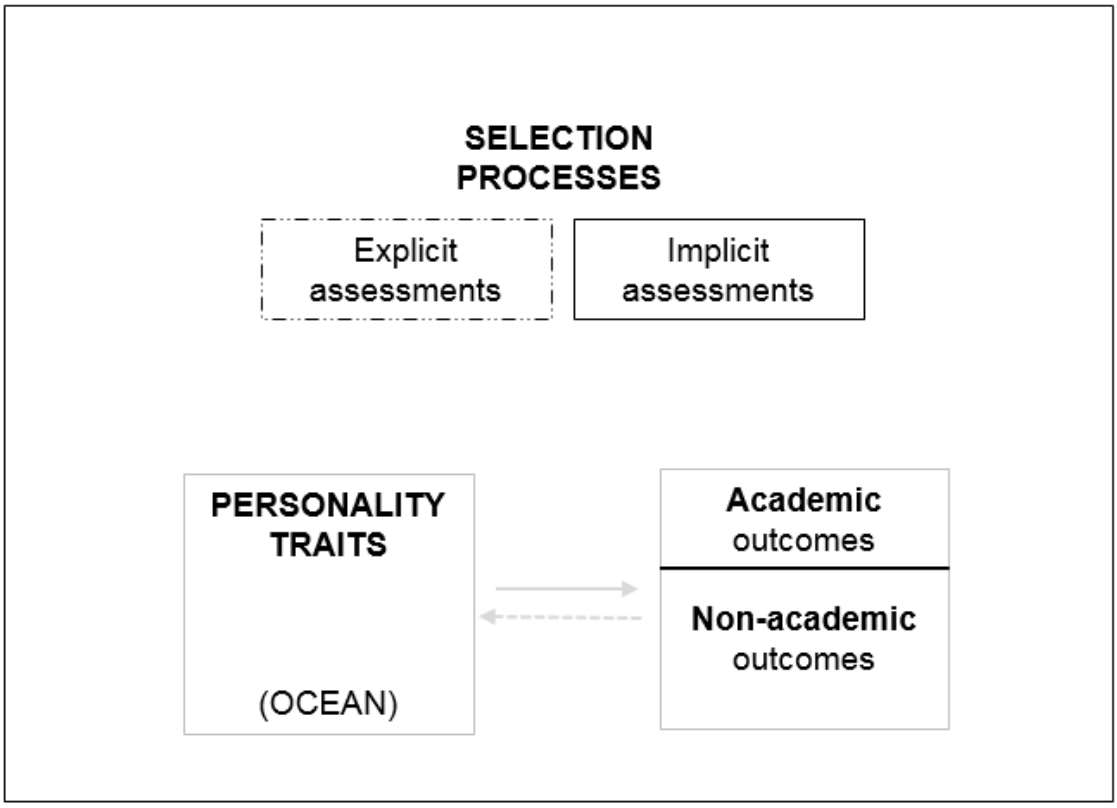

Figure 1. Open framework of the influence of personality traits in medical education.

Evidence on personality traits across lifespan has carried implications for research. Longitudinal studies on personality traits change have shown that the largest changes occur between ages 17 and 35 (25) . It seems that young adults change over time. The neosocioanalytic model of personality trait development has identified several causes of personality traits change, such as “age-graded” social roles; experiences in work; experiences in social relationships and the occurrence of positive or negative events (26, 27). Some of the examples of a negative event are the death of a family member, the end of a relationship or failing a test (25). More importantly, positive events were associated with increases in extraversion, whereas negative events were associated with

increases in neuroticism. Surprisingly, people who are more neurotic are more likely to seek out psychotherapy in general. Evidence demonstrates that therapeutic and psychological interventions promote personality traits change (28). In what concerns to medical education studies, it has been pointed out the lack of data that assumed personality traits as changeable (19).

2.2. Graduate entry medicine

The graduate entry medicine (GEM) is one complementary strategy to the inclusion of non-academic characteristics in widening access to medical education. Whereas in North America studying medicine is restricted to those who already have a university graduation (29), in other countries, for many years, the selection of future doctors occurred only from school-leavers with the highest achievements. However, Australia and UK commenced to have graduate entry approaches, and ever since, many other countries actively enrolled in policy initiatives to widen access to medicine, such as the admission of graduate applicants (30-32). The strongest argument for the introduction of graduate entry programmes was diversity. The competitive nature of entry to the medical and health professions meant that certain groups within populations were not well represented in medical school cohorts. Widening access to medical and health professional courses has been driven by socio-political concerns, aiming to include greater representation of ethnic minorities, low socioeconomic or disadvantaged groups or indigenous peoples (8). Enthusiasts of the GEM approach believe that delaying admission to medicine until after a first degree is obtained may allow applicants to develop specific knowledge and generic academic skills as they explore diverse interests. It has been argued that graduate students with broader pre-entry training and life experience will have a more understanding approach to patients, better interactional skills, and more diverse skills with which to cope with an increasing range of professional outcomes (33). Graduate entrants differ in socio-demographic (32) and in some psychological characteristics (34). When compared with school-leavers applicants, graduate students were significantly more conscientious, more confident, more self-controlled, more communitarian, more orientated and less anxious. However, some authors defend that graduates bring a distinct quality to a course, but that many of these relate to student's age. Older age at entry may

be more important than having a prior degree (35). On the other hand, some authors defend that is illegal to discrimante on the ground of age and that schoo-leavers are intelligent, multitalented, commited and come with exceleent study skills (36). In conclusion, graduate entry programmes aim to minimise the effects of disadvantage, increase the representation of students from diverse backgrounds, achieve a better match between the medical student population and the general population, and encourage more flexible and inclusive selection and admissions policies.

2.3. Portuguese medical students' selection context

Admission to a Portuguese medical school is extremely challenging and competitive because, as it happens in other countries, demand exceeds supply (37, 38). From a historic perspective, admission to a medical school in Portugal has been dominated by young school-leavers that go straight from secondary school into six-year long medical courses. Traditionally, Portuguese bright pupils are encouraged by their teachers and families to maximize their potential by aiming for the kudos and earning power of medicine. Failure to gain admission at the first application can lead them to other attempts or other trials or even to go study in a foreign medical school (e.g. Spain; Hungary;…). Medical school selection is a national seriation process that relies exclusively on previous achievement. This quantitative variable consists in students' secondary classifications and exit national examinations (Mathematics, Chemistry and Biology). Applicants are ranked according to their previous achievement and apply for the existent medical schools.

The publication of the decree law nº 40 of 20th of February of 2007 (39) has enabled GEM in our country from the academic year 2007/2008 and since then, Portuguese medical schools are considering graduate applicants besides the school-leavers entry. At present, Portugal has 8 national schools of medicine. University of Algarve has the only school of medicine that has been exclusively created for GEM students. In the case of the other seven medical schools (Escola de Ciências da Saúde da Universidade do Minho, Faculdade de Ciências da Saúde da Universidade da Beira Interior, Faculdade de Medicina da Universidade do Porto, Instituto de Ciências Biomédicas Abel Salazar, Faculdade de Medicina da Universidade de Coimbra, Faculdade de Medicina da

Universidade Lisboa e Faculdade de Ciências Médicas da Universidade Nova de Lisboa), all have a school-leaver entry quota and a GEM quota. Beira Interior and Minho have an undergraduate entry curricula (6-year long) and a GEM programme (4-years long). In respect of the remaining medical schools, GEM students may have some accreditations after being admitted, but have to attend the same undergraduate entry curricula that school-leavers do.

2.3.1 The case of the Faculty of Medicine of University of Porto

This medical school is 192 years old and had a traditional medical curriculum until the academic year 2013/2014, when a curricular reform was undertaken. This six-year medical course credits entitles the graduation in Basic Health Sciences after the completion of the first 180 ECTS credits. The conclusion of 360 ECTS credits for 12 semesters confers the MSc in Medicine. Until the publication of the above mentioned decree law, FMUP had only this system of school-leaver entry into discipline-based medical courses, designed to produce students literate in the biological sciences who would then enter clinical training. The selection process was based primarily on secondary school academic results (40). FMUP has a numerous clausus of 245 places available per year for the school-leavers entry and 37 for the graduate entry approach. Since the GEM entry approach began, 6 different regulations have been applied and 5 selection committees have been established. Over these ten years of the GEM approach in Portugal, FMUP has received 3086 applications and 342 graduates have been admitted and most are women (n=219). From these admitted graduates 94 have already completed the medical course. In the last few years it is increasing the number of medical students that attend other Portuguese medical schools and who take the opportunity to apply FMUP via this quota (41).

CHAPTER II

Aims

Aims

This research thesis aimed to contribute to a broader understanding of the role of personality traits on medical education outcomes.To achieve that, we have addressed two general objectives in which specific questions were studied:

a) The implications of using explicit and implicit measures of personality in the selection of medical students.

a.1. Is it possible to use self-report personality assessment in medical student's selection (Paper I)?

a.2. Do other medical selections tools such an admission interview is able to select different personality traits when compared to those selected exclusively on previous achievement (Paper II)?

b) The associations between personality traits and academic and non-academic outcomes along the medical course.

b.1. Is there an association between personality traits and empathy in medical students (Paper III)?

b.1.1. Is it possible that personal characteristics and psychopathology are associated along the medical course (PaperIV)?

b.2. How is the association between personality traits and academic achievement along the medical course (Paper V)?

CHAPTER III
Results – Paper I

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RESEARCH Open Access

Self-report personality tests and medical school selection

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Abstract

Background: There has been a growing interest on the assessment of personality when selecting medical students. However, how faking may affect its usefulness has been poorly addressed. Therefore, we aimed to assess the faking effect on self-report personality tests in the selection process of graduates to a medical school.

Methods: Sixty-seven graduates admitted as medical students completed the 60-item NEO Five-Factor Inventory (NEO-FFI) and the Marlowe-Crowne Social Desirability short-form scale at the stage of applying (baseline assessment) and after they had already been admitted (follow-up assessment). Reliability was assessed by the intra-class correlation coefficient and means of the personality traits compared by two paired sample *t* tests.

Results: At baseline assessment, the participants showed higher scores on the conscientiousness and lower scores on the neuroticism traits, respectively, 40.3 vs. 38.5 ($p = 0.026$) and 17.0 vs. 18.5 ($p = 0.089$). Also, at the follow-up assessment, the participants with low social desirability scored higher on the traits of openness to experience (−1.63 vs. 1.12, $p = 0.036$), conscientiousness (−3.09 vs. 0.03, $p = 0.022$), and neuroticism (3.88 vs. −0.69, $p = 0.017$).

Conclusions: Our study does not suggest the use of self-report personality assessment in medical student's selection as it can be faked particularly among applicants with low social desirability. Research is required to evaluate the faking effect on indirect personality assessment, namely through the tools that aim to select non-academic characteristics.

Keywords: Medical school selection, Personality assessment, Self-report personality tests, Faking effect, Graduate entry model, Longitudinal study

Background

Medical schools aim to select persons who besides becoming competent physicians in the future also express other competencies such as behaviour skills (Mahon et al. 2013). The importance of these competencies has been widespread in the medical education field. In our country, the "Medical Graduate in Portugal" is a document that defined 112 competences organised in five domains (knowledge, professional attitudes and behaviour, clinical skills and practical procedures, communication skills and general skills (Victorino et al. 2005).

Although for years medical students have mainly been selected based on academic achievement, there has been a recent and growing interest in the assessment based on personal attributes with particular emphasis on personality (Ferguson et al. 2003; Hojat et al. 2013; Lumsden et al. 2005). Some of the available medical selection tools which seek to choose other non-academic characteristics are interviews, mini multiple interviews (MMI) and situational judgement tests (Patterson et al. 2016).

In a historic perspective, admission to a medical school in Portugal has been dominated by young school-leavers, typically aged 18–19 years, and selection is based solely on their previous scholar achievement. However, since the 2007/2008 academic year, a graduate entry mode has been in force and each of the eight Portuguese medical school

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has its own criteria for admitting graduates. For this quota, some medical schools have a written examination followed by a MMI as selection process while others have chosen the combination of previous achievement and admission interview.

Few studies that relate personality traits with the existent medical selection tools show that different selection processes call upon different personality traits (Azman et al. 2014; Griffin and Wilson 2012; Jerant et al. 2012; Schripsema et al. 2014; Schripsema et al. 2016). For instance, if MMI performance is associated with extraversion (Griffin and Wilson 2012; Jerant et al. 2012), it has been shown that the admitted medical students with higher top pre-university grades have higher conscientiousness scores when compared to the lottery-admitted group (Schripsema et al. 2014; Schripsema et al. 2016). Nevertheless, the research on the selected personality traits with regard to the application of direct personality assessment by self-report personality tests is practically non-existent.

It has already been shown that under guidance, individuals can fake personality tests (Viswesvaran and Ones 1999). Faking consists of the deliberate false presentation of one's self that may be favourable (fake good) or unfavourable (fake bad) (Hayes et al. 2012). Various theories exist to explain the faking behaviour that can occur due to personal characteristics of an individual or as a result of contextual variables (McFarland and Ryan 2000; Snell et al. 1999; Tett and Simonet 2011). The majority of the faking research is cross-sectional, and participants receive instructions either to answer honestly ("honest conditions") or to make a good impression or to make a specific impression of themselves ("faking conditions") (Shoss and Strube 2011; Tett et al. 2012; Topping and O'Gorman 1997). In the endeavour to identify and avoid the faking behaviour when answering to personality tests, some strategies were devised such as the use of social desirability scales or the use of response times (Donovan et al. 2003; Holden and Lambert 2015). However, how faking may affect personality assessment usefulness in the medical selection field has been poorly addressed. With this study, we aimed to assess the faking effect on self-report personality tests in a real-life medical school selection process.

Methods

Context

The Faculty of Medicine of University of Porto (FMUP) has had the highest access ratings for secondary school-leavers in Portugal in the last decades. This population has 245 places available per year while the graduate entry approach has 37 places.

In addition, FMUP's graduate admission scheme is a two-phase selection process that comprises previous achievement and an admission interview.

Flow of the participants

The baseline assessment occurred at the stage of applying to the FMUP (April 2012 and April 2013). Applicants were asked to complete a personality measure (as part of a larger battery of psychometric tests) and were informed that their collaboration would not have any consequences for the selection process and that the selection committee would not have access to their information.

The follow-up assessment occurred after the selection process was complete and after applicants had already been admitted and enrolled in the FMUP (October 2012 and October 2013). The participants voluntarily completed the same psychometric tests again, but this time, a social desirability scale was included.

At baseline and on the follow-up assessments, questionnaires were sent by e-mail and the participants had 2 weeks to answer in their own time, unsupervised.

The study was reviewed and had the approval of the Ethics Committee of the Faculty of Medicine of the University of Porto, and the participants provided their written informed consent.

Although our participants were asked to respond honestly on both assessments and no manipulated instructions were given, we assume that our baseline and follow-up assessments correspond to the faking conditions and to the honest conditions settings, respectively.

Participants

The inclusion criteria for this study were (1) being admitted to FMUP; (2) having completed the questionnaires at baseline assessment; and (3) repeating the questionnaires at follow-up conditions. Of the 74 graduates admitted as medical students at the FMUP, 67 (90.5%) were eligible for this study (Fig. 1). Majority were women (80%) with a mean age of 27 years.

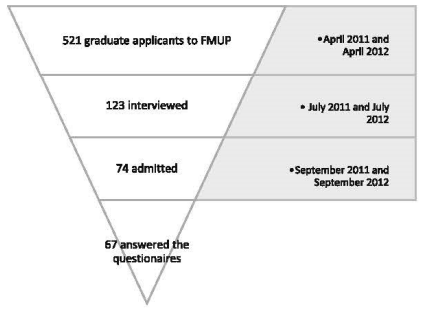

Fig. 1 Flow of the participants

Measures

Personality traits were assessed through the short version of the NEO Personality Inventory (NEO-PI-R), which is called the NEO Five-Factor Inventory (NEO-FFI). This 60-item, multiple-choice questionnaire evaluates five main dimensions of personality: openness to experience, conscientiousness, extraversion, agreeableness and neuroticism in a five-point Likert scale that ranges from 0 (strongly disagree) to 4 (strongly agree). Additionally, the NEO-FFI had already been validated for the Portuguese population (Magalhães et al. 2014).

The Marlowe-Crowne Social Desirability Scale is a measure of the influence of social desirability on test responses (Crowne and Marlowe 1960) that has been extensively used in personality research (Reynolds 1982). It consists of 33 items in a true-false response format. The items were chosen on the basis that they describe culturally approved behaviours that have a low incidence of occurrence and that response to items in the keyed or non-keyed direction have minimal implication of psychopathology (Crowne and Marlowe 1960). Short forms of this scale were developed and for this, study the 13-item form with a five-point Likert scale was used (Reynolds 1982).

Data analysis

The intra-class correlation coefficient (ICC) for a single measure was used to measure the reliability between baseline and follow-up assessments. Two paired sample *t* tests were used to compare the means of the personality traits between baseline and follow-up assessments. The participants were classified as high and low in social desirability according to the median of the final score on the Marlowe-Crowne Social Desirability Scale: the personality traits' mean difference between baseline and follow-up assessments was compared using two independent sample *t* tests. Pearson's correlation between personality traits and social desirability were estimated.

Results

The reliability between times of assessment was low for every personality trait (Table 1).

Significant differences were found for the conscientiousness and the neuroticism traits (Table 2) between times of assessment. More specifically, if the conscientiousness trait decreased significantly at the follow-up assessment ($p = 0.044$), the neuroticism trait increased significantly at that time of assessment ($p = 0.035$). However, the mean scores of the openness to experience, extraversion and agreeableness traits did not show significant differences between times of assessment.

There were significant differences between times of assessment for the traits of openness to experience (−1.63 vs. 1.12, $p = 0.036$), conscientiousness (−3.09 vs. 0.03, $p = 0.022$) and neuroticism (3.88 vs. −0.69, $p = 0.012$), for the group with low desirability than for the high desirability group (Table 3).

Regarding the correlation between personality traits and social desirability, it was stronger for all personality traits at the follow-up assessment except for extraversion that was stronger at the baseline assessment (Table 4).

Table 1 Reliability between times of assessment

Personality traits	ICC[a]
Openness to experience	0.254
Conscientiousness	0.459
Extraversion	0.318
Agreeableness	0.366
Neuroticism	0.411

[a]Intra-class correlation coefficient for a single measure

Table 2 Differences between times of assessment on personality traits.

Total				
	Baseline assessment	Follow-up assessment	Cohen's *d*	*p*
Personality traits	Mean (SD)	Mean (SD)		
Openness to experience	33.1 (3.89)	32.9 (4.38)	−0.036	0.781
Conscientiousness	40.3 (5.06)	38.5 (5.48)	−0.297	0.026
Extraversion	34.2 (4.88)	33.6 (4.52)	−0.123	0.338
Agreeableness	36.76 (4.42)	36.87 (3.97)	−0.007	0.953
Neuroticism	17.0 (6.93)	18.5 (6.90)	0.216	0.088

Discussion

This study has shown that participants faked on the personality traits of conscientiousness and neuroticism at the baseline assessment. Moreover, it was also found that participants with higher desirability levels were more honest at the follow-up conditions.

Table 3 Differences between times of assessment on personality traits stratified by desirability score (follow-up assessment-baseline assessment)

	Low desirability	High desirability	Cohen's *d*	*p*
Personality traits	Mean dif (SD)	Mean dif (SD)		
Openness to experience	*1.63 (4.99)*	*1.12 (4.81)*	0.545	*0.036*
Conscientiousness	*3.09 (4.52)**	*0.03 (5.55)*	0.594	*0.022*
Extraversion	−0.33 (4.55)	−0.97 (6.07)	−0.121	0.638
Agreeableness	0.13 (5.26)	−0.18 (4.16)	−0.067	0.798
Neuroticism	*3.88 (7.16)*[a]	*0.69 (6.94)*	−0.620	*0.012*

[a]Significant differences within the group
*Significant differences between follow-up and baseline assessments within this group
Italicized indicates that there were significant differences for the significant level of 0.005

Table 4 Pearson correlation between personality traits and social desirability

Personality traits	Baseline assessment	Follow-up assessment
Openness to experience	*R* (95CI %)	*R* (95CI %)
Conscientiousness	0.039 (−0.204, 0.278)	0.249 (−0.005, 0.473)
Extraversion	0.197 (−0.047, 0.419)	*0.506 (0.289, 0.673)*
Agreeableness	*0.348 (0.115, 0.544)*	*0.284 (0.038, 0.497)*
Neuroticism	*0.320 (0.085, 0.522)*	*0.450 (0.229, 0.628)*
Personality traits	−0.294 (−0.500, −0.056)	*0.617 (0.744, 0.431)*

Italicized indicates that there were significant differences for the significant level of 0.005

We believe that these results are due to the existence of some individual and contextual components of the faking process (Tett et al. 2012). It is possible that our participants could have not only the natural ability to fake (Tett and Simonet 2011) but also lower scores under honest conditions setting on the above-mentioned personality traits, having greater opportunity to fake at the faking conditions setting (Tett and Simonet 2011; Tett et al. 2012). We cannot ignore the fact that in our country like in so many others, there are much more applicants than available places in medicine (Patterson et al. 2016). In particular, the FMUP has had the highest access ratings for secondary school-leavers in Portugal over the last decades. Since our participants already hold a degree, and most of them wanted to study medicine since they were younger, we are in the position to assume that motivation was very high at this selection process. In addition, our participants came from a two-stage selection process in which stage 1 was based solely on previous achievement. It has been suggested that achievement is related to *g* (McManus et al. 2003) and also that cognitive ability (higher *g*) may facilitate the faking behaviour as brighter students seem to better identify which traits are job-relevant and therefore they fake accordingly (Tett et al. 2012).

However, the fact that had been already pre-selected by their previous achievement when they completed the personality measure is simultaneously a limitation of this study. As far as other study limitations, like other studies about medical student selection and personality testing, this is a single-centre study, which can lead to a selection bias because applicants usually apply to particular medical schools based on their personal preferences (Abbiati et al. 2016). In addition, unlike the personality measure, the social desirability scale was only administered at the follow-up assessment but we did not assess if desirability changed and if the association between social desirability and personality traits at baseline assessment was stronger or weaker when compared to the follow-up assessment. Furthermore, although important contributions to the faking research have been made with similar or even lower *n* (Shoss and Strube 2011; Robie et al. 2007), our small sample may have hidden results for other personality traits. Finally, our sample only comprises graduate participants whose average age is closer to the thirties whereas the high-school entrants are closer to the twenties which calls the generalisation of these findings to high-school entrants into question.

Nevertheless, our study also has important strengths as it is one of the first studies on medical selection that assesses the faking effect on self-report personality tests. Also, it was carried out in a real selection process setting and not in an imaginary faking setting with manipulated faking instructions (Shoss and Strube 2011; Tett et al. 2012; Topping and O'Gorman 1997). The most used self-report personality test was applied (Hojat et al. 2013), one that is already validated for the Portuguese population (Magalhães et al. 2014). Moreover, it is a longitudinal study while most of the published research about faking is cross-sectional (Shoss and Strube 2011; Donovan et al. 2003).

Conclusions

In conclusion, our study shows some evidence that the incorporation of personality self-report tests in medical student's selection it is not advisable and should be confirmed in other settings with larger samples and using different personality instruments.

We agree that selection processes must be rigorous and publicly defensible (Prideaux et al. 2011) and that personality assessment may play an important role to the selection of medical students. But we also believe that faking it is a demanding and complex task for the combination of all the existent components (Tett et al. 2012).

If medical schools select skilled applicants who are able to present a desirable image on personality assessment, they will be in danger of admitting someone low in the future physician-relevant traits (Tett et al. 2012). Moreover, they may especially get away with negative behaviours as medical students and as physicians.

Research is required to evaluate the faking effect on indirect personality assessment, namely through the tools that aim to select non-academic characteristics.

Authors' contributions

IL has made substantial contributions to the conception and design of the work and also to the acquisition, analysis and interpretation of the data; drafted the first version of the manuscript; and approved the final version submitted. Moreover, IL is accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. MAF and MS have made substantial contributions to the conception and design of the work and also to the acquisition analysis and interpretation of the data for the work, revised critically the manuscript for important intellectual content and approved the final version submitted. Moreover, MAF and MS are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All authors read and approved the final manuscript.

Competing interests
The authors declare that they have no competing interests.

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CHAPTER IV
Results – Paper II

ARTIGO ORIGINAL

Associations Between the Big Five Personality Traits and a Medical School Admission Interview

Associação Entre os Traços de Personalidade e uma Entrevista de Admissão a uma Escola Médica

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ABSTRACT

Introduction: Personality has became popular in medical student's selection. However, few research exists about the association between the big five personality traits and the existent medical school selection tools. Our aim was to study which personality traits were selected by a medical school admission interview.

Material and Methods: One hundred ninety four graduate applicants that had applied to the Faculty of Medicine of the University of Porto through the graduate entry approach, after ranked on previous achievement, were interviewed between the academic years of 2011 and 2013. From these, 181 (93.3%) answered to the NEO Five-Factor Inventory that assesses high order personality traits of openness to experience, conscientiousness, extraversion, agreeableness and neuroticism. Admission interview corresponded to the second phase of the seriation process. Every applicant was interviewed and scored by three interviewers on seven dimensions asesssed by Lickert scale (1-10). Interview score was the sum of the dimensions. Linear mixed effects model and respective regression coefficients were used to estimate the association between personality traits from each interviewer's score. Final models were adjusted for gender, interviewers and previous achievement.

Results: Openness to experience (Beta = 0.18: CI 95%: 0.05; 0.30) had the strongest association with interview score followed by the interaction effect between the extraversion and conscientiousness traits (Beta = 0.14; CI 95%: 0.02; 0.25). Also, applicants scored higher when their gender was opposite to the interviewers.

Discussion: Previous achievement and interview score had no association.

Conclusion: Our admission interview selected different personality traits when compared to other selection tools. Medical schools should be aware of the implications of the adopted selection tools on the admitted medical student's personality because it can help providing beneficial interventions.

Keywords: Interviews as Topic; Personality; Portugal; School Admission Criteria; Schools, Medical; Students, Medical/psychology.

RESUMO

Introdução: A avaliaçao da personalidade tem ganho popularidade na seleção de estudantes de medicina. Todavia, existe pouca investigação acerca dos traços de personalidade escolhidos pelos diferentes métodos de seleção. O nosso objetivo consistiu em estudar os traços de personalidade selecionados através de uma entrevista de admissão a uma escola médica.

Material e Métodos: Cento e noventa e quatro candidatos licenciados concorreram à Faculdade de Medicina da Universidade do Porto pelo contingente especial e foram entrevistados nos anos académicos de 2011-2013. Cento e oitenta e um (93,3%) responderam ao NEO *Five-Factor Inventory* que avalia os traços de abertura à experiência, conscienciosidade, extraversão, agradabilidade e neuroticismo. A entrevista correspondia à segunda fase do processo de seriação. Cada candidato foi entrevistado e avaliado por três entrevistadores relativamente a sete dimensões por escala de Lickert (1-10). O resultado da entrevista correspondia à soma das classificações das dimensões. Utilizaram-se modelos de efeitos lineares mistos e respetivos coeficientes de regressão para estimar a associação entre os traços de personalidade com o *score* dos entrevistadores. Os modelos finais foram ajustados para género, entrevistadores e sucesso prévio.

Resultados: Abertura à experiência (Beta = 0,18: IC 95%: 0,05; 0,30) apresentou a associação mais forte com o *score* da entrevista seguida da interação entre os traços de extraversão e conscienciosidade (Beta = 0,14; IC 95%: 0,02; 0,25). Os candidadatos tinham maior *score* quando o seu género era oposto ao dos entrevistadores.

Discussão: Não houve associação entre o sucesso prévio e o *score* da entrevista.

Conclusão: A entrevista de admissão escolheu traços de personalidade diferentes dos escolhidos por outros métodos de seleção. As escolas médicas poderão planear intervenções adequadas se conhecerem as implicações dos processos de seleção na personalidade dos estudantes admitidos.

Palavras-chave: Critérios de Admissão Escolar; Entrevista; Escolas Médicas; Estudantes de Medicina; Personalidade; Portugal.

INTRODUCTION

The selection of medical students is the first step to ensure the development of tomorrow's physicians.[1] For many years this selection was exclusively weighed on academic achievement. Changes brought the use of interviews in the selection of medical students,[2] and in the last decade, the multiple mini-interview (MMI) has also become a popular selection tool.[2,3]

Moreover, there are other medical selection tools such

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as references, personal statements, letters of intent, essays and/or situational judgement tests[2] – some of which aim to select other non-academic characteristics. The assessment of personal attributes has had more followers in recent years[4-6] and the inclusion of personality and emotional intelligence (as selection tools) has been under much debate.[7,8] Nowadays, personality assessment has been at the forefront[8,9] of medical selection criteria and the same is true of other career areas such as business or commerce.[8] It is currently possible to assess personality with intruments such as the NEO Personality Inventory (NEO PI-r), which is increasingly used in medical education.[6-8] This instrument is available for the assessment of the five-factor model (FFM) that comprises the broad trait dimensions of openness to experience, conscientiousness, extraversion, agreeableness, neuroticism and their more specific facets as one of the most widely accepted taxonomic structures of personality.[10] This model provides a framework of informed personality research in organisational studies[11] due to its ability to predict the performance of individuals in different occupational settings[12] mostly because of the conscientiousness trait suggested as being the most consistent trait in predicting good work outcomes across different contexts.[11] A review of personality and medical education has also emphasised the conscientiousness trait as a significant long term success predictor in medical training.[13]

Personality can be assessed directly by self-report personality tests but it has been shown that applicants can fake on personality self-report tests.[14] Or we can study which are the personality traits that are selected by the existing selection tools. In the medical education field, the existing studies about who is being selected for medical schools have relied mostly on written tests or academic achievements and more recently on MMI. In these studies, results show the positive effect of the 'conscientiousness' and of the 'extraversion' traits[15,16] in the selection score, but it is still unknown which traits are selected during other interview methods in the selection of medical students.

At the Faculty of Medicine of the University of Porto (FMUP), the graduate entry approach comprised for some years, a two-phase selection process: previous achievement and an admission interview. The first phase of the seriation process ranked applicants based on their previous achievement once it has been showed that previous achievement predicts posterior achievement.[2,17,18] Neverthless, it isn't absolutely certain that high achievers have other important attributes that are needed from the very beginning.[2] In this context, FMUP's selection committee decided to hold an admission interview in order to pursue other personal characteristics of the admitted applicants. And from among the available selection tools, only two require the existence of external examiners: interviews and MMI. We opted by the admission interview because 1) it is one of the most common medical selection measures highly valued by admission committees[2,19] and by interviewers[2]; 2) there was no validation of either of the two tools at the time; 3) FMUP had institutional policies of cost containment and MMI could lead to higher costs.[20] Furthermore, it is important to mention that there have been several attempts to increase the reliability and validity of interviews[21] by establishing a more structured format[22,23] and by providing interviewers with specific training,[24] which was taken into account in our admission interview design and implementation. Therefore, this study aimed to assess which personality traits were selected by a medical school admission interview.

MATERIAL AND METHODS

Context

Since the academic year of 2007/2008, Portuguese medical schools, besides secondary school-leaver entrants, also started to have a graduate entry mode. Every Portuguese medical school has its own criteria for the admission of graduates, and at FMUP secondary school leavers have 245 places avalailable per year and the graduate entry approach has 37 places. In addition, FMUP's graduate admission scheme, at the time of this stidy was a two-phase selection process that comprised previous achievement and an admission interview.

Seriation process of the graduate entry mode at FMUP

Phase one (P1) was associated with previous achievement and applicants were ranked in descending order compared to their average grades obtained in national examinations at the end of secondary education in the subjects of Mathematics, Chemistry and Biology.

The 74 applicants with the highest averages become eligible for phase two (P2) – the admission interview (N = 74 corresponds to twice the number of places available for this entry mode). If the main goal of the first phase was to sort among the highest achievers, the admission interview aimed to select other personal characteristics that go beyond academic success.

In the years of 2011, 2012 and 2013, 309 graduate applicants applied to FMUP, a total of 194 were interviewed and 94 were admitted as medical students.

Personality traits

Personality traits were assessed through the short version of the NEO Personality Inventory (NEO-PI-R), which is called NEO Five-Factor Inventory (NEO-FFI). This 60-item, multiple-choice questionnaire evaluates the five main dimensions of personality: openness to experience, conscientiousness, extraversion, agreeableness and neuroticism in a five-point Likert scale that ranges from 0 (strongly disagree) to 4 (strongly agree). Additionally, the NEO-FFI has already been validated on the Portuguese population.[25]

This assessment ocurred during the application period to FMUP (April 2011, April 2012 and April 2013) and every applicant was asked to participate in the study. They were informed that their collaboration would not have any consequences on the selection process and

that the selection committee would not have acess to their information. Therefore, participants voluntarily completed this personality measure (as part of a larger psychometric battery). Questionnaires were sent to the applicants by e-mail and they had two weeks to answer the questions in their own time (unsupervised).

Admission interview

Admission interview (AI) refers to the second phase of the seriation process, which entailed the adoption of, between the years of 2011 and 2013, a fixed panel interview format made up of three interviewers.

Interviewer 1 was a male and was aged 38 during the first year of interviewing. Interviewer 2 was a 30 year-old female and Interviewer 3 was a 57 year-old female. Interviewer 2 was a clinical psychologist and interviewers 1 and 3 were medical doctors and held a position in basic sciences at FMUP. All of the interviewers had selection experience in both postgraduate admissions and at other Portuguese medical schools.

The interview script and the methodologies to be used were developed by the interviewers in colaboration with a Human Resources consulting company. Consequently, an "Interviewer's Manual" was produced and interviewers were trained before participating.

The interview had seven general dimensions: 'Motivations to study medicine', 'Scientific and medical culture', 'Academic or professional routes and other developed activities', 'Humanistic culture', 'Career transition', 'Time and stress management' and 'Overall performance in the interview'. Every dimension was given a score by the three interviewers with the use of a Likert scale (1 to 10 range). Accordingly, interviewers had to score every applicant on each dimension with the following scale: (1-2) totally inappropriate, (3-4) inappropriate, (5-6) sufficient, (7-8) above average and (9-10) outstanding.

Naturally, every dimension was previously clearly defined, which included characteristics and job competencies that would be needed for someone to be proficient as a medical student and as a physician. A pool of questions was designed for every dimension and interviewers participated equally in the interview process by asking three questions per dimension.

To ensure greater evaluation objectiveness and transparency, assessment guidelines were made available for the interviewers. These guidelines had general rating indicators such as: level of preparation for the interview, critical thinking, communication skills and emotional control. Further to these competencies that should be demonstrated in all of the answers, there were other specific rating indicators. Hence, for example, regarding the 'Scientific and medical culture' dimension, applicants who had shown to know Portugal's strategic plan for health and were able to freely dicuss it would have a better score. The assessment occurred throughout the interview process or imediatelly after it, was done individually and interviewers were not allowed to exchange any infomation about the applicant's performance. Likewise, interviewers had no access to application forms and interviews lasted between thirty to forty minutes. Additionally, interviewers had to answer an extra question that did not contribute to the interview's score: 'Should this applicant be admitted to FMUP?' – a research question designed to study the internal validity of the AI.

Participants

This study considered the applicants that were interviewed and that had completed the NEO-FFI during their application to FMUP. There was a total of 181 participants which represented 93.29% of the total population interviewed (n = 194).

Furthermore, this study was reviewed and had the approval of the Ethics Committee of the Faculty of Medicine of the University of Porto/S. João Hospital Centre (public corporation); participants provided their written informed consent to participate in this study and were fully aware that this collaboration would not have any consequences on the selection process or beyond (in case of admittance to FMUP).

Data analysis

To study the reliability of the AI, the variance components of applicants, dimensions and interviewers were estimated and the absolute reliability of the AI was calculated.

The variance components were estimated using a random effect model with random effect by applicant, dimension and interviewers as well as all of the possible two-way interaction effects.

Conjointly, in order to reach a reliability of 0.7, the optimum number of interviewers and dimensions were studied.

The score of each interviewer was calculated as being the sum of the seven dimensions.

What is more, a linear mixed effects model with a random effect by applicant to estimate the association between personality traits and each interviewer's score was used. The Beta coefficients from the mixed effects model were used to estimate the association between the score of the interviewer and the five personality traits.

All of the quantitative variables in the model (applicants' score, personality traits and the 'should be admitted' question) were standardised.

Final models were adjusted for gender, interviewer and for previous achivement. Other applicants' personal characteristics, such as age, ethnicity, marital status, parents' qualifications or the application year were also studied, but did not influence the final score of the interview (data not shown).

The quantitative variables like personality traits and previous achievement were standardised in order to compare the effect between variables.

Table 1 - Components of variance of the admission interview

	n	Variance	SD	% total variance
Applicants	194	0.847	0.920	30.0
Dimensions	7	0.299	0.547	10.6
Interviewers	3	0.024	0.154	0.8
Applicants x Dimensions	1321	0.165	0.406	5.8
Applicants x Interviewers	565	0.576	0.758	20.4
Dimensions x Interviewers	15	0.122	0.349	4.3
Residual (D x I x A)*	4072	0.794	0.891	28.1

*A: Applicants; I: Interviewers; D: Dimensions

RESULTS

Characterisation of the participants

From the 181 participants, 39 were men (21.5%) and 142 were women (78.5%); the majority were single (80.7%) and the mean age was 27.28 (± 3.46). The participants were all white and with the exception of a Brazilian applicant, everyone else (99.4%) was Portuguese.

In terms of the education level of the participants' parents, the interquartile range varied from incomplete secondary education to PhD holders. Most of the respondents' parents were employed, 60.0% (mother) and 59.4% (father), respectively.

Reliability of admission interview

Table 1 shows that the main source of variance in the AI were the applicants (30.0%), and it demonstrates that most of the variability in the assessment was due to differences between applicants. This was as expected considering that the purpose of the interviews was to differentiate applicants. The second main source of variance (20.4%) was the interaction 'Applicants x Interviewers' that shows that some applicants do better or worse with specific interviewers. The remaining components together explain 21.5% of the variability of the final score interview. Finally, the residual percentage (28.1%) was considerable in comparison to the remaining sources of variance, which means that other sources of variance exist and are worthy of identification.

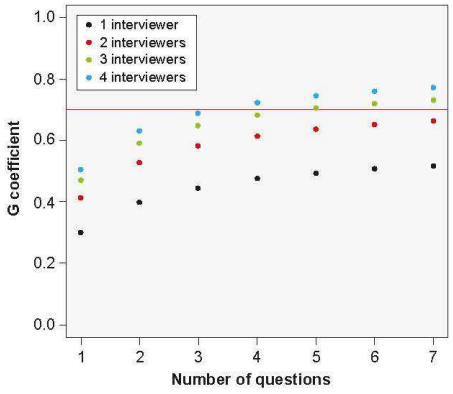

Figure 1 – Reliability coefficient according to the number of questions and number of interviewers

The absolute reliability of this interview with seven dimensions and executed by three interviewers was 0.73.

However, it was also possible to estimate that the cut-point of 0.7 of reliability of this interview could be achieved by keeping the same number of interviewers and reducing the number of dimensions to a maximum of five (Fig. 1).

Personality traits and admission interview

The openness to experience trait was positively associated with the final score of the AI (Beta = 0.18: CI 95%: 0.05; 0.30) (Table 2, Model 1). Moreover, a positive interaction between extraversion and conscientiousness traits and the final score of the AI was also obvious (Beta = 0.14; CI 95%: 0.02; 0.25) (Table 2, Model 1).

Concerning the other personality traits, no significant associations with the final score of the AI was demonstrated (Table 2, Model 1).

Gender differences were visible in the interview's scoring. This is, when the gender of the applicants was opposite to that of the interviewers, applicants had higher scores (gender of applicants: interviewers) (Table 2, Model 1).

After adjusting the research question 'Should this applicant be admitted to FMUP?', the same personality traits remain significant. Notwithstanding, the effect of openness to experience and the extraversion and conscientiousness interaction effect decreased approximately 50%. This research question showed a strong association with the final score of the AI (Beta = 0.61; CI 95%: 0.55; 0.68).

Previous achievement did not show a significant association with the final score of the AI (Table 2, Model 1).

DISCUSSION

There was no association between the final score of the AI and previous achievement, showing that our AI measures different personal attributes when compared with a selection tool exclusively based on achievement. This was the expectation once our admission interview explicitly aimed selecting other personal characteristics. Regarding what personality traits were selected by the AI, results show a strong association with the open-ness to experience trait, followed by the interaction effect between the extraversion and conscientiousness traits. Openess to experience is

Table 2 - Mixed effects models with random effect by applicant for the standardised score of the interviewers

	Model 1	Model 2
Applicants' Gender	β (CI 95%)	β (CI 95%)
Female	Ref	Ref
Male	-0.20 (-0.55; 0.16)	-0.10 (-0.22; 0.02)
Interviewers		
1	Ref	Ref
2	0.22 (0.07; 0.37)	-0.24 (-0.49;0.02)
3	0.15 (0.00; 0.30)	0.07 (-0.08; 0.22)
Applicants's Gender: Interviewers		
Male Applicants: Interviewer 1	Ref	
Male Applicants: Interviewer 2	0.34 (0.02; 0.66)	0.32 (0.01; 0.63)
Male Applicants: Interviewer 3	0.65 (0.33; 0.97)	0.44 (0.12; 0.75)
Academic Achievements		
Biology	-0.02 (-0.16; 0.12)	-0.05 (-0.14; 0.03)
Mathematics	-0.04 (-0.16; 0.09)	-0.03 (-0.10; 0.04)
Chemistry	-0.03 (-0.18; 0.11)	-0.02 (-0.11; 0.06)
Personality Traits		
Neuroticism[1]	-0.02 (-0.16; 0.12)	0.01 (-0.07; 0.09)
Extraversion[1]	0.07 (-0.07; 021)	0.03 (-0.05; 0.12)
Openness to experience[1]	0.18 (0.05; 0.30)	0.08 (0.01; 0.16)
Agreebleness[1]	-0.04 (-0.19; 0.10)	0.02 (-0.07; 0.10)
Conscientiousness[1]	-0.12 (-0.26; 0.02)	-0.10 (-0.18; -0.01)
Extraversion: Conscientiousness[1]	0.14 (0.02; 0.25)	0.09 (0.02; 0.15)
'Should this applicant be admitted to FMUP?'	---	0.61 (0.55; 0.68)

Model 1: Adjusted for all the variables in the table with the exception of 'Should this applicant be admitted to FMUP?'

Model 2: Adjusted for all the variables in the table;

[1] The variables were standardised

linked with creativity and divergent thinking,[26] with being imaginative,[27] flexible, inclined towards new ideas[28] and with being more empathetic,[29,30] which can be advantageous in academic and/or work performance metrics (clerkship evaluations, patient care) of future physicians. This result is different when compared with studies on MMI where extraversion is the trait that has the major effect. It is possible that high scores in the openness to experience trait and high scores in the AI are due to the assessment guidelines that valued either critical thinking either original and spontaneous answers. Thus, these competencies can be easily expressed for those who tend to adopt different perspective-taking, i.e. high in openness to experience.[31]

Results also show an interaction between interview scores and the extraversion and conscientiousness traits. Once again, these are different results when compared with MMI[15,16] because during the AI applicants had to be, simultaneously, high-extravert and high-conscientious. If high extraverts tend to be sociable and energetic,[32] they can also lose status over time.[33] High scorers on conscientiousness are individuals that reveal to be responsible and industrious[9,32] and seem more likely to outperform others,[11] but being overly conscientious may compromise fast decision-making.[34] This result can be a consequence of the amount of time that applicants had to spend with the three different interviewers at the same time, which can increase pressure but also provide interviewers a holistic understanding of the applicants. Subsequently, if on the one hand the most extravert applicants are impressive at the beginning due to their communication skills, as time passes, and when question complexity increases, they must clearly evidence knowledge. On the other hand, having the required knowledge is not enough if they are not able to express themselves clearly. Thence, the AI can be seen as an advantage when compared with other selection tools in which eight minutes is the maximum amount of time that examiners and interviewees can spend together.[35] This is so because it is easier to 'keep the mask on' when there is less interaction time. Inclusively, lengthening station duration has already been recommended for MMI.[36,37]

In any case, it is important to mention that these characteristics were observed in a group of participants that had already been pre-selected based on their previous achievement.

Although the focus of this study was on the personality of the applicants, it is not possible to ignore the fact that the personality of the interviewers can also affect the final score had in the interviews. This happened, for example, with

gender. Results show that gender influences the final score of the AI. We found that when the gender of the applicants was different from that of the interviewers' they had a higher interview score. In some studies women applicants were scored lower than men by both male and female interviewers,[38] and in other studies female applicants were scored higher than male applicants during the interview process.[39] This finding has an important implication as it addresses the need to have more studies on the impact of gender on selection, but mainly on how to build assessment committees and improve methodologies that involve external examiners such as interviews and MMI.

A possible limitation of this study could be the reliability and validity of the AI. Still, the AI on which this study was based showed similar reliability with previous MMI studies. In actual fact, whilst overall reliability in interviews for the selection of medical students tends to be poor,[4,21,24] this study showed a good reliability (0.73) in consonance with other results.[23] Furthermore, a good reliability of the MMI was established with a median reliability of 0.73[36] and a recent systematic review about the MMI for student selection in health professions still in training reported a moderate to high reliability, with Cronbach's alpha = 0.69 an G-coefficient = 0.55 - 0.72.[40] Moreover, this finding can be associated with the colaboration of a Human Resources consulting company that ensured that the design and implementation of the interviews was executed with attention to accuracy and detail. They oversaw, for example, the prior and clear understanding of the definition of the selection criteria for each dimension, the questions to be asked, the interview structure, the previous training of the interviewers and the assessment guidelines. In truth, this is not very different from the recommendations that were recently addressed to MMI,[3,37,41] which highlight the importance of a careful and rigourous design. Equally, it is imperative to meet the need to align the vision and mission of medical schools with the students who are selected. In addition, this study shows that maintaining the same number of interviewers (n = 3) and reducing the dimensions to be assessed to a maximum of five items, the mentioned AI would have identical reliability. Convincingly, results show the internal validity of the AI as its final score was strongly related with the research question that interviewers had to answer.

This study's major limitation is the fact that it was conducted at only one medical school which could make it unclear as to whether these findings could be generalised to other settings. However, at least 12% of the applicants are common to other three Portuguese medical schools that have different selection criteria for the graduate entry mode, whereby there is confidence that, at the very least, these findings can be extrapolated to Portugal.

CONCLUSION

In conclusion, this study shows that the executed AI is reliable and selects different personal traits when compared to other selection tools. If the selection of medical students is the first step to ensure the development of tomorrow's physicians,[1] medical schools should be aware of the implications of the adopted selection tools on the admitted medical student's personality. Also, we believe that the information gathered during the selection process can provide beneficial interventions.[42] Future research should focus on worthwhile correlations with selection tools and should provide clear, solid and practical clinical outcomes.

PROTECTION OF HUMANS AND ANIMALS & DATA CONFIDENTIALITY

This study was reviewed and had the approval of the Ethics Committee of the Faculty of Medicine of the University of Porto/S. João Hospital Centre (public corporation); participants provided their written informed consent to participate in this study and were fully aware that this collaboration would not have any consequences on the selection process or beyond (in case of admittance to FMUP).

CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest.

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CHAPTER V
Results – Paper III

Are personality traits really weak/moderate predictors of empathy?

Dear Sir

We read with great interest the article by Magalhães et al. (2012) in a recent issue of Medical Teacher that assessed empathy in medical students with the Jefferson Scale of Physician Empathy and found that personality traits are weak or moderate predictors of empathy.

In this context, we administered the 28-item Interpersonal Reactivity Index (IRI) and the 60-item NEO Five Factor Inventory (NEO-FFI) to 65 first year medical students 2012/2013 academic year. The IRI comprises several statements with corresponding five-point likert scale (0 = does not describe me well, 4 = describes me very well) and measures four separate aspects of empathy through four subscales: perspective-taking (PT), fantasy scale, empathic concern (EC) and personal distress (PD).

The NEO-FFI was designed to assess the high order personality traits of extraversion, agreeableness, conscientiousness, neuroticism and openness to experience (0 = disagree, 4 = agree).

We have found positive significant correlations between the total score of IRI either with agreeableness ($r = 0.628$, $p < 0.001$) and openness to experience ($r = 0.522$, $p < 0.001$), it was stronger in our study. Thus, in our case, the logistic regression model using the five dimensions NEO-FFI to predict top tercile empathy revealed excellent discrimination (area under the ROC curve = 0.824, 95% CI = 0.72–0.93).

Additionally, when we assessed the correlations with each IRI sub-scales and NEO-FFI, we found positive correlations between PD and neuroticism ($r = 0.512$, $p < 0.001$), EC and extraversion ($r = 0.287$, $p = 0.021$) and between PT and conscientiousness ($r = 0.356$, $p < 0.001$), contradicting the results of that study that only demonstrated associations with openness to experience and agreeableness.

In summary, our study shows a higher discrimination ability of the NEO-FFI to predict top tercile of empathy. Is it possible that freshman medical students may be more similar to general population than to physicians, and so IRI can be a better option to assess empathy either in the first year of the medical course or even in the admission process to medical schools.

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Response to "are personality traits really weak/moderate predictors of empathy?"

Dear Sir

The results described in the Letter To The Editor in response to our manuscript describes support our conclusions that personality traits and empathy are correlated. The authors used a different scale to measure empathy – the Interpersonal Reactivity Index (IRI) – and described correlations between IRI total scores and Big5 personality traits higher than the ones we found between JSPE and the same traits. The concurrence of both studies strengthens the hypothesis that something about students' empathy is conditioned by personality. The authors found a contradiction in the results of the two studies concerning the correlation between conscientiousness and empathy scores. We would argue this is not the case since we reported correlations of JSPE total score with Conscientiousness (as displayed in Table 2) even though only Agreeableness and Open to Experience were significant predictors of falling into the top-top tercile of JSPE scores. We also believe that the correlations of personality with IRI-subscores will not necessarily have the same meaning than the correlations with total JSPE scores. The items on the IRI ask the respondent to answer how he/she identifies she/herself with the item whereas the JSPE items ask respondents to assess the importance of the item within the physician/patient relationship.

The authors raise reservations on the use of JSPE to capture the empathy of 1st year students. This is a thoughtful issue as JSPE has been developed and trialed with the intention of being "specific for patient care situations" (Hojat et al. 2001) and was adapted to US medical students, whose profile would be probably more equivalent to European 4th year students – nevertheless the JSPE structure has been replicated internationally (Costa et al. 2012). However, related to the JSPE, the IRI scale has the limitation of having been developed with no intention to capture the specificities of medical education. To decide on which is the best scale to use for first year students, we believe it would be important to clarify methodological and conceptual issues. Methodologically, it would be important to assess and test the possible moderating role of year of study in the relation between the IRI and JSPE scores, and the relation of both empathy scores and personality traits. Conceptually, we need to answer questions such as to what extent medical schools expect admitted medical students to differ in empathy from the general population, what distinguishes the two empathy constructs and which would be the appropriate period in which the empathy of the entering student would evolve in to "medical student empathy". We believe that longitudinal empathy studies

CHAPTER VI
Results – Paper IV

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Original Article

Self-concept and obsessive-compulsiveness as moderators of anxiety and depression: a Portuguese prospective study

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ABSTRACT

Objective: Research shows a high prevalence of psychopathology among medical students. This study aims to assess the time trend of depression, anxiety, self-concept and obsessive-compulsiveness in medical students within the first year (short-run) and over the years (long-run) of medical school, and to measure if self-concept and obsessive-compulsiveness predict anxiety and depression trends.

Methods: At baseline, 183 freshman students that enrolled at FMUP in the 2002/03 academic year were recruited; from these, 71 (39%) participated in the short-run study and were assessed at the beginning and at the end of the first year and 151 (83%) participated in the long-run study (assessed in the first, third and fifth year). Participants answered three self-report questionnaires: the Hospital Anxiety Depression Scale (HADS), the Maudsley Obsessive-Compulsive Inventory (MOCI) and a self-concept scale.

Results: In the long-run, there was a negative linear trend with time for the MOCI score (B=−0.68, p<0.001) and for the HADS anxiety score (B=−0.28, p<0.001), a positive linear trend for self-concept (B=1.37, p<0.001) and no association with depression (B=−0.05). The short-run results were opposite given that anxiety, depression and obsessive-compulsiveness increased and no differences were found for self-concept.

After adjusting for self-concept and obsessive-compulsiveness, there was no effect of time on anxiety but there was a negative interaction between self-concept and time on depression scores.

Conclusions: The effect of time on depression is moderated by a protective effect of self-concept, while obsessive-compulsiveness explained time trends on anxiety scores.

It is important to understand and find the pathways of anxiety and depression to improve medical students' mental health.

Background

Medical students' mental health has been exhaustively studied showing high scores of stress, anxiety, depression and burnout when compared with other groups of the same age group or even in other graduate degrees.[1–3]

Research has shown an association between personal characteristics and anxiety and/or depression scores[1–5]; and some studies have focused on personal characteristics such as self-concept, obsessive-compulsiveness and distress.[4,6]

According to some authors, self-concept is a multidimensional construct, having one global dimension (global self-concept), to which all of the other dimensions contribute and this is related with self-esteem.[1,7] In literature, this has been linked with depression symptoms[8] and a Portuguese study demonstrated a negative correlation between global self-concept, and anxiety and depression symptoms.[9]

An obsessive-compulsive disorder consists of obsessive thoughts such as excessive doubting and compulsive behaviours such as frequent washing.[10] It seems that obsessive-compulsive symptoms are associate with perfectionism and consequently with depression.[2]

The relation between certain personality traits measured early in the course of medical school and later mental health among junior physicians during postgraduate internship training has been high-

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lighted.[1] A twelve year longitudinal study showed that stress, burnout and satisfaction with medicine as a career in doctors correlate and were partially predicted by measures of personality traits taken five years earlier.[2]

The aim of this prospective study was: 1 - to assess the time trend of depression, anxiety, self-concept and obsessive-compulsiveness in the first year of medical school (short-run study); 2 - to assess the time trend of depression, anxiety, self-concept and obsessive-compulsiveness over the years of medical school (long-run study) and 3 - to measure if the self-concept and obsessive-compulsiveness moderates the anxiety and depression time trends.

Material and methods

Participants

At baseline, 183 freshman students that enrolled at FMUP in the 2002/03 academic year were recruited; from these, 71 (39%) participated in the short-run study and 151 (83%) participated in the long-run study.

In the short-run study, participants were assessed twice in their first year: at the beginning of the academic year (October 2002) and at the end of the academic year (June 2003).

For the long-run study, participants were assessed at three different moments: the beginning of the first academic year (October 2002), the beginning of the third year (November 2004) and the beginning of the fifth year (November 2006). Of 151 participants enrolled in the long-run study, 145 (96%) participated in the third year and 77 (51%) participated in the fifth year.

Instruments

In both studies, participants had to answer three self-report questionnaires. The Hospital Anxiety Depression Scale (HADS)[12,13] was used to assess anxiety and depression symptoms. This scale consists of 14 items (seven items for each dimension) with four ordinal options (0-3 points). The higher (lower) the score, the higher (lower) the anxiety or depression. A score higher than seven, on either sub-scale, indicates borderline anxiety or depression.

The obsessive-compulsive symptoms were measured with the Maudsley Obsessive-Compulsive Inventory (MOCI).[14] This questionnaire is widely employed in clinical settings and consists of 30 true-false items. The higher (lower) the score, the higher (lower) the obsessive and compulsive symptoms.

A 20 item self-concept scale[15] was used, where the higher (lower) the score, the higher (lower) the self-concept.

Statistical analysis

The average score intra-class correlation coefficients (ICC) was used to measure the variance attributed to differences among subjects of the total variance and indirectly measuring the variance attributed to differences within subjects.

Paired sample t-tests and linear mixed-effects models were used to estimate short- and the long-run trends in each dimension assessed and to measure the influence of self-concept and compulsive behaviour on the anxiety and depression scores.

All statistical analyses were calculated in R 2.8.0.

Results

The ICC for anxiety, depression, self-concept and obsessive-compulsive symptom scores indicated moderate agreement between all of the different observations (short and long measurements). The ICC was 0.66, 0.53, 0.60 and 0.65 for the anxiety, depression, self-concept and obsessive-compulsive scores, respectively.

Short-run effect

The comparison between students who participated in the short-run study (n=71) and students who did not participate (n=112), had no statistical differences in the first assessment between anxiety, depression, self-concept and obsessive-compulsive scores.

However, there was a statistical significant increase in the score of obsessive-compulsive symptoms, and in the anxiety and depression score within the first year. The anxiety mean score increased from 6.9 (SD=3.6) to 7.9 (SD=4.5) and the depression mean score increased from 3.2 (SD=2.4) to 4.7 (SD=3.3) (Table 1). The obsessive-compulsive score increased from 8.5 (SD=4.4) to 10.2 (SD=5.9). In the self-concept scale score, there were no statistical significant differences (76.7 (SD=7.5) versus 75.6 (SD=7.5)) (Table 1).

After adjusting for obsessive-compulsiveness, there was a positive association of the obsessive-compulsive scores with anxiety and depression scores. After adjusting for self-concept, the effect of time in anxiety scores disappeared and there was a negative interaction between self-concept and time on depression scores, showing that the association of self-concept with depression was modified by time of the assessment. The association between self-concept and depression was stronger at the end of the academic year (Table 2).

Long-run effect

The comparison between students who participated in the fifth year (n=77) and students that did not participate (n=74), showed no statistical differences between their anxiety, depression, self-concept and obsessive-compulsive scores in the first assessment.

Table 1
The short-run effect (within the first year) for obsessive-compulsiveness, anxiety, depression and self-concept

	N	First year Start	First year End	P
		Mean (SD)	Mean (SD)	
Maudsley Obsessive – Compulsive Inventory	68	8.5 (4.4)	10.2 (5.9)	0.006
HADS				
Anxiety	67	6.9 (3.6)	7.9 (4.5)	0.033
Depression	67	3.2 (2.4)	4.7 (3.3)	<0.001
Self-concept scale	71	76.7 (7.5)	75.6 (7.5)	0.175

Table 2
Models to predict the anxiety and depression scores within the first year

Model	Anxiety β	P	Depression β	P
Model 1[a]				
Start of the year	Ref		Ref	
End of the year	0.52	0.286	1.09	0.003
Self-concept	−0.38	0.387	−0.22	0.445
End year x Self-concept	0.23	0.656	−1.13	0.003
Model 2[b]				
Start of the year	Ref		Ref	
End of the year	0.50	0.314	1.08	0.004
Obsessive-compulsiveness	1.65	0.002	0.95	0.009
End year x Obsessive-compulsiveness	−0.45	0.416	−0.30	0.456

[a] Adjusted for sex and obsessive-compulsive score.
[b] Adjusted for sex and self-concept.

The obsessive-compulsive score showed a negative trend with time and inversely, self-concept showed a positive trend. In the case of the HADS assessment, there was a negative trend with time and anxiety and no statistical significant trend with depression scores. The obsessive-compulsive mean score diminished 0.68 points and the anxiety mean score diminished 0.28 points each year; the self-concept mean score increased 1.37 points each year (Table 3).

After adjusting for self-concept and obsessive-compulsiveness, there was a negative association of self-concept with anxiety (β=−0.99, p=0.001) and depression scores (β=−0.69, p=0.004) and a positive association of obsessive-compulsive symptoms with anxiety (β=0.966, p=0.003) and depression scores (β=0.65, p=0.002). The effect of time on anxiety scores disappeared and there was a positive association between time and depression. However, the interaction term, showed that the association of self-concept with depression was modified by time, as time passes, the association between self-concept and depression is stronger (Table 4), given that the protective effect of self-concept in the fifth year is higher (β=−0.93, p=0.035) than compared with that of the first year.

Discussion

The results showed an important tracking effect of the scores of anxiety and depression, self-concept and obsessive-compulsiveness over medical school, meaning that overall, the personal variables that were studied are somehow intrinsic or more stable (the variance attributed to differences among subjects of the total variance ranged from 0.53 and 0.66). Nevertheless, there are opportunities for some intervention initiatives in order to improve medical student's mental health given that the variance attributed to differences within subjects ranged from 0.34 and 0.47, showing that there was some variability in the mean scores of anxiety, depression, self-concept and obsessive-compulsiveness within subjects over the years. This can be showed by the mean scores of anxiety that ranged from 5.7 to 7.9 over the course of medical school, depression scores ranged from 2.7 to 4.9 and obsessive-compulsive scores ranged from 4.97 to 10.2.

Table 3
The long-run effect (between the first, third and fifth year) for obsessive-compulsiveness, anxiety, depression and self-concept

	First year	Third year	P	Fifth year	P	Trend	P
Maudsley Obsessive –Compulsive Inventory	8.70	7.06	<0.001	4.97	<0.001	−0.68	<0.001
HADS							
Anxiety	6.89	5.70	<0.001	5.93	0.024	−0.28	<0.001
Depression	3.24	3.10	0.587	2.97	0.468	−0.05	0.428
Self-concept scale	75.9	79.5	<0.001	83.1	<0.001	1.37	<0.001

Table 4
Models to predict the anxiety and depression scores at long-run

Model	Anxiety	P	Depression	P
	β		β	
Model 1[a]				
Year 1	Ref		Ref	
Year 3	−0.44	0.126	0.43	0.078
Year 5	0.69	0.252	1.45	0.035
Self-concept	−0.99	0.001	−0.69	0.004
Year 3 x Self-concept	0.073	0.817	−0.22	0.389
Year 5 x Self-concept	−0.132	0.803	−0.93	0.035
Model 2[b]				
Year 1	Ref		Ref	
Year 3	−0.40	0.158	0.49	0.045
Year 5	0.31	0.543	0.93	0.027
Obsessive-compulsiveness	0.966	0.003	0.65	0.002
Year 3 x Obsessive-compulsiveness	−0.142	0.639	0.04	0.859
Year 5 x Obsessive-compulsiveness	−0.77	0.084	0.07	0.851

[a] Adjusted for sex and obsessive-compulsive score.
[b] Adjusted for sex and self-concept.

The maximum scores of anxiety, depression, obsessive-compulsiveness and the minimum of self-concept were reached at the end of the first academic year. It is important to have in consideration that this study happened before some curricular reforms and because of this, the first examination period as university students happened at the end of the academic year. Considering the four moments of our study, this was the time at which higher scores of distress were observed. These results corroborate the findings of Bolger,[18] who shows that as the examination period approaches, individuals show increased anxiety scores.

The crude analysis performed over the course of medical school showed that there was a negative trend with time for the anxiety and obsessive-compulsive scores followed by a positive trend with self-concept scores. These findings show that all of the studied variables' time trends are closely related to each other. There was no trend with time for the depression scores.

When we measured to what extent the obsessive-compulsive scores and self-concept explained the anxiety and depression trends, results showed that the anxiety trend was attenuated and the depression scores showed a negative interaction with time trend and self-concept.

The attenuation of the anxiety trend by self-concept and obsessive-compulsiveness could be explained by adaptation to the new academic environment throughout the medical school, due to a learning curve of adaptive coping strategies, which increases the sense of control by the students and consequently their self-concept (self-esteem) increased, while obsessive-compulsive and anxiety scores decreased.

These findings could suggest that anxiety scores are more related with academic adaptation given that in the first year students did not yet have time to adapt to the new environment and learn adaptive coping strategies, which is showed by an increase in obsessive-compulsive scores and the maintenance of similar scores of self-concept.

This study also indicated that the effect of self-concept in depression is moderated by the years, showed by significant interaction of self-concept and the years of medical school. As the years progress, the relation between self-concept and depression increases, which means the same level of self-concept in the fifth year will have a more protective effect of depression compared with that of the first year. The same happened in the short-run study, where the students who maintained the same level of self-concept immediately before the examination period had a higher protective effect of self-concept. In moments of higher depression (end of the first and the fifth year), the self-concept had a strong protective relationship with depression.

In conclusion, the main result that our study provides is that the trend of anxiety at the long-run was explained by self-concept and/or obsessive-compulsiveness and that the trend at the short-run had similar results, showing the importance to design specific targeted interventions.

Another finding that might arise relates to the increase of depression with time, independently of the relation between self-concept with depression and obsessive-compulsiveness with depression.

Finally, this study shows that self-concept is an important factor to diminish depression when this is presented with high scores.

It is also important to point out that these students were all recent high school graduates, who were admitted to FMUP considering only their academic achievements, which can lead us to rethink medical school admission. Nevertheless, additional research to improve our understanding of the causes leading to medical student distress and to investigate potential solutions to overcome these situations is likely to benefit not only our students, but have a strong repercussion on future physician workforce.

This study highlights the need to understand and to improve medical students' mental health.

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CHAPTER VII
Results – Paper V

PLOS ONE

RESEARCH ARTICLE

Personality and achievement along medical training: Evidence from a cross-lagged analysis

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Abstract

Introduction

Evidence on personality traits change implies it should be studied as an outcome and not only as an explanatory effect. Therefore, we aimed to assess how personality and academic achievement sway each other. Three cohorts of medical students (n = 181) comprised of school leavers and graduates, completed NEO-FFI when admitted (baseline) and later on medical training (follow-up). Previous achievement was measured as mean scores on national school examinations, and academic achievement as medical course average. Causal relations were studied by cross-lagged analysis.

Results

Cross-sectional analysis at baseline showed differences between graduates and school leavers on personality, with graduates scoring lower on neuroticism ($\beta = -12.344$, $p<0.001$), and higher on openness to experience ($\beta = 5.257$, $p<0.001$), conscientiousness ($\beta = 2.345$, $p = 0.004$,) and agreeableness ($\beta = 6.993$, $p<0.001$). Longitudinal analyses indicated that personality traits and achievement tracked over time. Cross-lagged analysis found a positive significant association between academic achievement and neuroticism at baseline ($\beta = 0.031$, $p = 0.014$) and with being a graduate student ($\beta = 0.766$, $p = 0.006$). After adjusting, no association was found between previous achievement and personality at follow-up.

Conclusions

Some neuroticism may enhance medical academic achievement. The blurring of the initial differences between graduates and school leavers suggests a reasonable possibility of personality traits change along the medical course.

Future research on medical selection processes cannot afford to ignore the influence of the medical school environment on personality traits change.

Introduction

The selection of medical students is under debate for years and yet it seems to be an unresolved challenge [1]. Tomorrow's doctors are required to express specific skills and personal attributes besides being well qualified and competent technicians [2]. This paradigm shift in academic medicine has had effects in the selection processes and in some medical schools' curriculums [3]. For many years, selection has relied heavily on previous achievement, shown to be important for progression through medical school and beyond, so that applicants admitted on the basis of their previous achievement had lower levels of dropout[4–6]. However, it cannot be assumed that those with high academic ability alone can be turned into competent physicians via medical training, as personal characteristics may need to be present from the beginning [7]. In recent years, there has been a proliferation of medical selection tools that aim to pursuit non-academic characteristics among the academically well-qualified applicants, such as interviews [8], mini-multiple-interviews (MMI) [9] or situational judgement tests[10]. Also, it has been shown how different medical selection tools can call upon different personality traits [8,11].

The influence of personality traits on important life outcomes such as health, well-being, job performance and career success [12,13] has contributed to the proliferation of personality assessment in different fields of knowledge. In the medical education field, the five-factor model (FFM), or Big Five, is one of the most used [14]. FFM comprises the broad trait dimensions referred to as OCEAN: openness to experience, conscientiousness, extraversion, agreeableness, neuroticism (or emotional stability which is the opposite of neuroticism) and their more specific facets [15]. For example, personality traits have already been linked to empathy in medical students [16] and to mental health [17]. As regarding the association of personality traits with medical academic achievement, the personality trait of conscientiousness appears to be a predictor of success [18]. Yet this association is not linear because there is some evidence that this trait may be positively associated with knowledge-based assessment, but negatively associated with some clinical aspects of medical school assessment [7]. There are also some concerns that personality tests are 'fakeable' when used for medical student's selection. Indeed, past research had already shown that individuals can fake in line with the requirements of particular jobs[19,20]. Faking consists of the deliberate false presentation of the self that may be favourable (fake good) or unfavourable (fake bad) [21]. In addition, a recent study has suggested that graduate applicants who have participated in a medical school selection process, have faked on self-report personality tests [22].Account must be taken of the fact that some of these studies, besides having a cross-sectional design, have conceptualized personality traits only as explanatory variables. This conceptualization is in accordance with a perspective of personality traits as deterministic and stable all over a lifetime and that do not develop through experience [23]. However, there has been evidence that personality traits show meaningful and statistically significant mean-level change in young adulthood, middle age and even at old age [24]. Built into this principle is the assumption that personality traits remain open systems that may be influenced by the environment. This does not mean that they are necessarily influenced by the environment or that they must change, but rather that they have the capacity for change at any age [23]. Personality traits change seems to be more predominant in young adulthood [25], and specific positive or negative life experiences, life goals, abilities and social roles may be some of the presumed causes of changing [26,27]. Thus, it is required that any predictive model must integrate the assumption that personality traits remain changeable throughout the life cycle.

Recently, it has been identified the lack of data on personality change and its implications for healthcare professional's health, performance but also for the medical selection research.

The selection of a specific trait is itself of limited validity in the face of dynamic trait change and context specificity of trait expression [28]. Hence, for this study, we adopted a position in agreement with personality development theories wherein the person variables and social situations are both integrated [23,24]. In methodological terms, it implies that personality traits must also be studied as outcomes and not only as explanatory effects. For this purpose, we used a cross-lagged panel design because it allows at least two assessments at different time points. Therefore, we aimed to assess how personality and medical academic achievement sway each other.

Material and methods

Contextualization

Admission to a Portuguese medical school is extremely challenging and competitive because, as it happens in other countries, demand exceeds supply. From a historic perspective, admission to medicine has been dominated by young school leavers, typically aged 18–19 years. School leaver's selection is a national seriation process that relies exclusively on previous achievement. This quantitative variable consists in student's secondary classifications and exit national examinations (Mathematics, Chemistry and Biology). Applicants are ranked according to their previous achievement and apply for the existent medical schools.

A decree law established in 2007 that every medical school had to have a graduate entry mode apart from the school leaver's selection process. From the existent seven public medical schools, only one is exclusively for graduate students. The other medical schools have both school leavers and graduate quotas, and are autonomous to decide on the selection practices to adopt in the graduate entry approach. For example, while some medical schools have adopted a written examination followed by a MMI, others have chosen the combination of previous achievement and admission interview.

For the last decades, the Faculty of Medicine of the University of Porto (FMUP), has been the first option of the school leavers in Portugal presenting the highest access ratings. This medical school is 192 years old and has had a traditional medical curriculum until the academic year 2013/2014, when a curricular reform was undertaken. This six-year medical course credits entitles the graduation in Basic Health Sciences after the completion of the first 180 ECTS credits. The conclusion of 360 ECTS credits for 12 semesters confers the MSc in Medicine.

FMUP has 245 places available per year for school leavers and 37 for the graduate students. At the time of this study, the graduate entry selection practices comprised a two-phase process: previous achievement and admission interview. The first phase ranked applicants based on their previous achievement. The highest achievers were eligible for the admission interview that aimed to pursue personal characteristics that go beyond academic success [8].

Although some medical schools adopted a specific curriculum for graduates, this did not occur at FMUP. At our faculty, all students attend the same medical course, even though graduates may have some recognition of previous academic performance.

Flow of the participants

We used information from three cohorts of graduate students and for each graduate we selected one school leaver admitted on the same academic year. Baseline assessment occurred during participant's first month as medical students at FMUP. They were asked to complete a personality measure (as part of a larger battery of psychometric tests). Follow-up assessment occurred in April 2016, which means that the first cohort was assessed 5 years after, the second cohort was assessed 4 years after and the third cohort was assessed 3 years after having been

admitted to medicine. Participants voluntarily completed the same psychometric tests again (Fig 1).

At baseline and at follow-up assessments, questionnaires were sent by e-mail and participants had two weeks to answer in their own time, unsupervised. Participants were asked to respond honestly on both assessments and no manipulated instructions were given.

Participants

From the 3 cohorts of medical students comprised of secondary school leavers and graduates who were admitted to FMUP between 2011 and 2013, a total of 181 medical students participated in this study (Fig 1). At baseline assessment, from the 111 eligible graduates, 96 (86. 5%) participated, and from the 146 school leavers we invited to collaborate, 134 (91.8%) agreed to participate in the study. At follow-up, from the 96 graduate participants at baseline, 91 collaborated once again, and from the 134 school leavers 90 (67.2%) also participated (Fig 1). From 181 participants, 49.7% were graduate and the majority were women (65.7%).

Measures

Personality traits were assessed through the short version of the NEO Personality Inventory (NEO-PI-R), which is called the NEO Five-Factor Inventory (NEO-FFI). This 60-item, multiple-choice questionnaire evaluates five main dimensions of personality: openness to experience, conscientiousness, extraversion, agreeableness and neuroticism in a five-point Likert scale that ranges from 0 (strongly disagree) to 4 (strongly agree). Additionally, the NEO-FFI had already been validated for the Portuguese population [29].

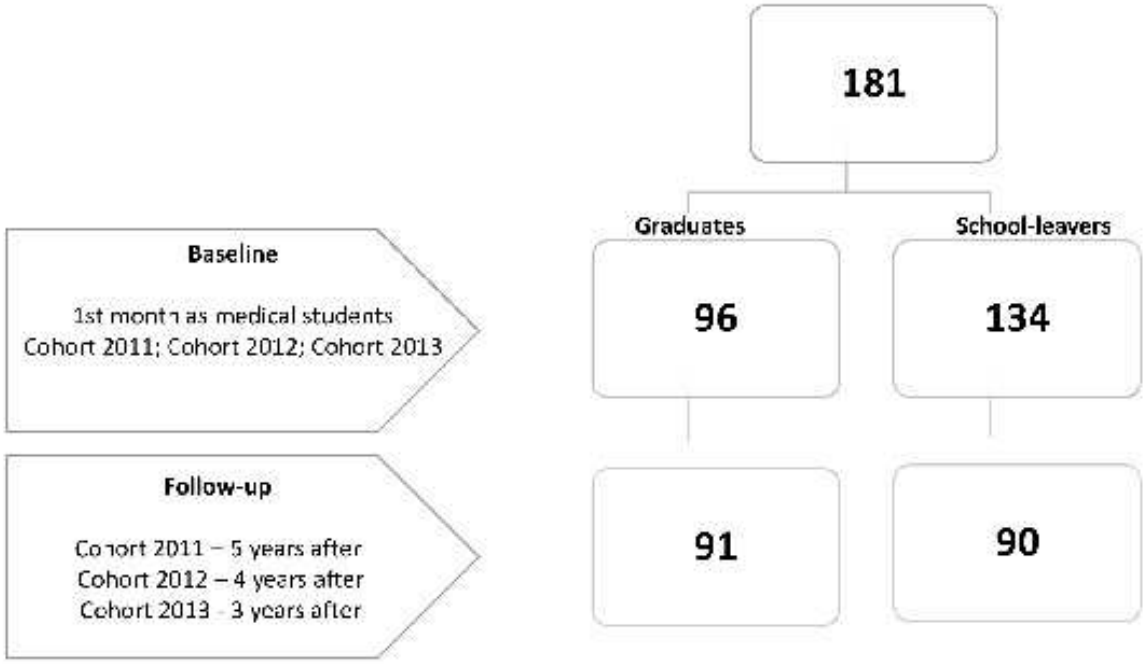

Fig 1. Flow of the participants.

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Previous achievement

Previous achievement was measured as the mean scores of every participant exit national school examinations on Mathematics, Chemistry and Biology. Scores were between 0 and 200. The Z-scores transformation (subtract the mean of the examinations and divided by the respective standard deviation) was applied to each score and the mean of the 3 examinations was then calculated.

Academic achievement

Academic achievement was measured as the medical course average. If the first three years are mainly Basic Sciences theory oriented, thereafter there is a high clinical focus. From the fourth year onward, medical students attend clinical practice units that require close contact with patients. These clinical practices take place at FMUP affiliated health facilities, mostly based in the north of Portugal. They include public hospitals (S. João Hospital centre is the most interactive one), private hospitals and health centres. Subjects in which graduates have had previous recognition due to their past academic or professional experience were discarded for this variable design, and the mean of the scores was calculated for each graduate.

Data analysis

To estimate the association between the exposure and outcomes, linear regression models were used to calculate regression coefficients (β) and the respective 95% confidence intervals (95% CI). Interaction terms were tested between achievement and personality traits, but also between graduates and the previous variables. Additionally, a cross-lagged panel design analysis was performed to investigate the causal relations [30]. The conceptual model is described in Fig 2. This model includes three linear regressions: a) a cross-sectional analysis between personality traits at baseline and previous achievement; b) a longitudinal analysis in which we performed a linear regression between personality traits at follow-up and personality traits at baseline, and between academic achievement at follow-up and previous achievement at baseline; c) a cross-lagged analysis between personality traits at baseline and academic achievement at follow-up.

For linear regression models, homoscedasticity and normality of errors distribution were evaluated. In all analyses, we considered a p value <0.05 as statistically significant. Statistical analysis was conducted using SPSS statistical software package version 21 (SPSS Inc., Chicago, IL, USA).

Ethical considerations

This study was approved by the Ethics Committee of the Faculty of Medicine of the University of Porto and Hospital de São João, and policies and procedures were developed to guarantee data

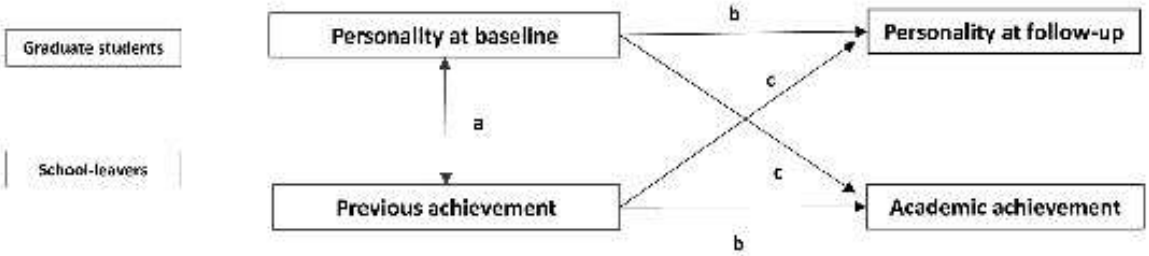

Fig 2. Conceptual model of the cross-lagged association between personality and achievement.

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confidentiality and protection. Participants received written and oral information explaining the purpose and the design of the study and written informed consent was obtained.

Results

We found a positive association between previous achievement and the neuroticism trait at baseline (β = 4.578, p<0.001, Table 1). With regard to previous achievement and the other personality traits at baseline, negative associations were found with openness to experience, conscientiousness and agreeableness traits (β = -1.533, p = 0.004; β = -1.398, p = 0.008; β = -2.590, p<0.001, respectively). No associations were found between previous achievement and the extraversion trait (β = -0.605, p = 0.220, Table 1).

Graduates showed lower levels in the neuroticism trait at baseline when compared to school leavers (β = -12.344, p<0.001, Table 1), but scored higher in the personality traits of openness to experience (β = 5.257, p<0.001, Table 1), conscientiousness (β = 2.345, p = 0.004, Table 1) and agreeableness (β = 6.993, p<0.001, Table 1). There was an interaction between graduates and previous achievement on personality traits (data not shown).

In the longitudinal approach, it was observed that personality traits and achievement tracked over time. Every personality trait assessed at baseline was significantly positively associated with the same trait assessed at follow-up: openness to experience (β = 0.273, p<0.001, Table 2), conscientiousness (β = 0.225, p<0.001, Table 2), extraversion (β = 0.174, p = 0.012, Table 2) agreeableness (β = 0.315, p<0.001, Table 2) and neuroticism (β = 0.406, p<0.001, Table 2). Previous achievement was significantly positively associated with posterior academic achievement (β = 0.352, p = 0.007, Table 3).

At follow-up a positive association between neuroticism and being a graduate student was found (β = 2.627, p = 0.065, Table 2).

The crude association at follow-up showed that, when compared to school leavers, graduates scored higher on the personality traits of agreeableness and extraversion (β = 0.234, p = 0.001; β = 1.630, p = 0.008, Table 2) and scored lower on the neuroticism trait (β = -2.714, p = 0.009, Table 2). After adjusting, the difference between both populations was smaller than at baseline (β = -12.344, p<0.001) with graduate students scoring a little more on the neuroticism trait than school leavers (β = 2.627, p = 0.065, Table 2).

Table 1. Cross-sectional association between personality traits and previous achievement at baseline.

		Crude β (95CI %)	P
Personality traits at baseline			
Openness to experience			
	Previous achievement	**-1.533 (-2.573, -0.494)**	**0.004**
	Graduates	**5.257 (3.808, 6.706)**	**<0.001**
Conscientiousness			
	Previous achievement	**-1.398 (-2.430, -0.366)**	**0.008**
	Graduates	**2.345 (0.755, 3.936)**	**0.004**
Extraversion			
	Previous achievement	-0.605 (-1.576, 0.365)	0.220
	Graduates	-0.315 (-1.837, 1.208)	0.684
Agreeableness			
	Previous achievement	**-2.599 (-3.660, -1.535)**	**<0.001**
	Graduates	**6.993 (5.570, 8.415)**	**<0.001**
Neuroticism			
	Previous achievement	**4.578 (2.760, 6.396)**	**<0.001**
	Graduates	**-12.344 (-14.719, -9.970)**	**<0.001**

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Table 2. Cross-lagged associations between personality traits and previous achievement at follow-up.

Outcome	Exposure	Crude β (95CI %)	P	Adjusted β (95CI %)*	P
Personality traits at follow-up					
Openness to experience					
	Openness to experience at baseline	0.225 (0.115, 0.336)	<0.001	**0.273 (0.143, 0.402)**	**<0.001**
	Previous achievement	-0.519 (-1.339, 0.300)	0.213	-0.559 (-1.486, 0.368)	0.236
	Graduates	0.597 (-0.659,1.843)	0.349	-1.132 (-3.07, 0.812)	0.252
Conscientiousness					
	Conscientiousness at baseline	0.267 (0.150, 0.383)	<0.001	**0.0225 (0.092, 0.359)**	**0.001**
	Previous achievement	-0.589 (-1.458, 0.278)	0.181	0.259 (-0.699, 1.217)	0.485
	Graduates	1.779 (0.445, 3.113	0.009	1.658 (-0.352, 3.669)	0.105
Extraversion					
	Extraversion at baseline	0.215 (0.098, 0.332)	<0.001	**0.174 (-0.086, 0.211)**	**0.012**
	Previous achievement	-0.083 (-1.675, -0.091)	0.029	-0.226 (-0.699,1.217)	0.608
	Graduates	1.630 (0.425, 2.834)	0.008	0.871 (-0.353, 3.669)	0.346
Agreeableness					
	Agreeableness at baseline	0.330 (0.231, 0.428)	<0.001	**0.315 (0.166, 0.463)**	**0.001**
	Previous achievement	-0.895 (-1.727, -0.064)	0.004	-0.026 (-0.911, 0.859)	0.954
	Graduates	0.234 (0.983, 3.485)	0.001	0.267 (-1.597, 2.131)	0.778
Neuroticism					
	Neuroticism at baseline	0.372 (0.285, 0.460)	<0.001	**0.406 (0.279, 0.534)**	**<0.001**
	Previous achievement	1.300 (-0.044, 2.645)	0.058	0.046 (-1.279, 1.371)	0.945
	Graduates	-2.714 (-4.762, -0.665)	0.009	**2.627 (-0.163, 5.418)**	**0.065**

*Adjusted for all personality traits at baseline, previous achievement and graduates.

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Cross-lagged analysis showed a positive significant association between being a graduate student and academic achievement (β = 0.766, p = 0.006, Table 3). In the cross-lagged association between personality traits assessed at baseline and academic achievement at follow-up, a positive significant association was found between the neuroticism trait at baseline and academic achievement (β = 0.031, p = 0.014, Table 3). No other significant associations were found for the other personality traits (Table 3). Regarding the cross-lagged association between previous achievement and personality traits at follow-up, it was not significant for any personality trait (Table 2).

Table 3. Cross-lagged associations between academic achievement and personality traits at baseline.

Outcome	Exposure	Crude β (95CI %)	P	Adjusted β (95CI %)*	P
Academic achievement at follow-up					
	Openness to experience at baseline	0.000 (-0.031, 0.033)	0.955	-0.010 (-0.046; 0.026)	0.581
	Conscientiousness at baseline	0.014 (-0.018, 0.046)	0.399	0.018 (-0.018;0.054)	0.311
	Extraversion at baseline	-0.006 (-0.431, 0.026)	0.63	0.006 (-0.034; 0.046)	0.777
	Agreeableness at baseline	0.0144 (-0.016, 0.044)	0.344	0.019 (-0.024; 0.063)	0.385
	Neuroticism at baseline	0.007 (-0.010, 0.025)	0.394	**0.031 (0.006; 0.561)**	**0.014**
	Previous achievement	0.189 (-0.036, 0.415)	0.099	**0.352 (0.095; 0.610)**	**0.007**
	Graduates	0.241-(0.11, 0.591)	0.177	**0.766 (0.223; 1.309)**	**0.006**

*Adjusted for all variables.

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Discussion

On the basis of our conceptual model (Fig 2), this study has confirmed the cross-lagged association between personality at baseline and academic achievement at follow-up. However, it did not confirm the cross-lagged association between previous achievement and personality at follow-up. It was also found that personality traits and achievement tracked over time. In addition, graduates and school leavers showed different personality traits at the beginning, but along the medical course it seems that graduates have increased their neuroticism and academic achievement.

Heterogeneity of personality traits between school leavers and graduates population at baseline has been shown with the latter, scoring higher on openness to experience, conscientiousness and agreeableness and lower on the neuroticism trait. This result corroborates studies that found that graduates may contribute to widen psychological diversity [31]. Still, it must be mentioned that these graduates are the same who had scored higher on the traits of openness to experience, extraversion and conscientiousness in their admission interview [8]. This fact reinforces that different medical selection tools call upon different personality traits among applicants [11]. Although this heterogeneity seems to keep the same direction at crude cross-lagged analysis, after adjusting, graduates have increased their neuroticism scores. It must be mentioned that despite the mean levels of neuroticism have increased at follow-up it were still lower than the other personality traits.

The association between personality traits with previous achievement at baseline, irrespective of whether one was a graduate or a school leaver, confirms that previous achievement can be a surrogate variable of personality traits. In addition, previous achievement was negatively associated with openness to experience, conscientiousness and agreeableness, and positively associated with neuroticism, with the association being maintained at the crude cross-lagged analysis. However, after adjusting for the tracking effect (longitudinal analysis has shown that all outcomes—personality and achievement- tracked over time), previous achievement no longer had any effect on personality change, meaning that it is not a personality change explanatory fact.

The cross-lagged analysis has shown that medical academic achievement can be determined by the neuroticism trait at baseline, being a graduate student, and previous achievement. On one hand, this study confirms the extensive research about the positive association between previous achievement and academic achievement [32–34]. On the other hand, unlike previous studies, we have not found the conscientiousness trait to be a predictor of medical academic achievement [35,36], but rather the neuroticism trait. This is an important result as it has been mooted that conscientiousness is considered a key trait when selecting medical students [33]. Yet this is not an absolute novelty. Tett had already shown that being conscientious is not always beneficial because detail-oriented people may take a very long time compromising fast decision-making [37]. More recently, it has been evidenced that the association between one conscientiousness and learning outcomes may change in direction (from enhancing to inhibiting) as context changes. All together led to a growing awareness that traits like conscientiousness also have a 'dark side' and traits like neuroticism, have a 'bright side' [38]. Or according to the evolutionary theory of personality, every trait has simultaneously its 'costs and benefits'. The neuroticism personality axis is associated with variation in the activity levels of negative emotion systems such as fear, sadness, anxiety, and guilt. However, if the negative effects of neuroticism are well-known in the psychological literature its benefits are not so widespread [2]. The fact is that neuroticism seems to be positively correlated with competiveness [3] and among university students, it has been shown to be positively associated with academic achievement [4, 5]. A longitudinal study in a Swedish upper secondary school sample has

found the same association [39]. In addition, in the medical education research it has also been highlighted that those who have moderately higher levels of neuroticism perform better on anxiety-provoking part of the course [38]. It is possible that the anxiety component of neuroticism due to its anticipatory ability can have facilitated performance in some of these individuals who may have strategically channelled the negative affect to promote high levels of preparation, competitiveness, and striving to attain a better position [37][38][34][33]. This behaviour reflects greater vigilance and supports the tendency to move towards the object of anxiety to control it[40]. This means that it seems better to be a bit neurotic than to be stable in what regards getting good marks.

Notwithstanding these benefits of some levels of neuroticism that can serve as a motivator in the competitive medical school environment, we cannot forget its evident drawbacks. Its negative effect as a strong predictor of stress and burnout among medical students and doctors is well-known [17,41,42]. In addition, a prevalence of poorer mental health has been shown among medical students when compared with other populations of the same age [43]. It is also important to highlight that a successful medical student won't be necessarily a competent or a healthy/happy doctor [7,44]. Moreover, these medical students were assessed either in the initial years of the medical course or in their clinical years with more patient care experience. This has made us reflect if the available assessment methods on the medical course do privilege cognitive performance. Another interesting fact of this study was the positive relationship between being a graduate student and medical academic achievement. We know that most of these graduates were not admitted to medicine while school leavers were admitted because of their previous achievement (data not shown). According to a neo-socioanalytic theory, the social roles are the primary conduit through which environment affects personality. The ability to model (watching others) is also embedded in roles such as those found at medical school. This can be seen in the formal mechanism of performance feedback. It is possible that graduate students may be under the impression that they are performing well (identity perception), until their professors/ school leaver colleagues provide less than flattering performance feedback (reputation). Similar feedback mechanisms may affect change in traits and interests as people acquire information about their social reputation from others in the environment. Hence, changes can occur through watching ourselves do things differently, often in the context of a new role or in response to new role demands [23]. It is also possible that, due to their previous experiences, graduates have further valued their role as medical students [45] and have engaged in task-oriented behaviours to avoid the threat of appearing incompetent to others [46]. In some way, the fear of failure or of causing a bad impression can enhance medical academic achievement. Furthermore, graduates were the population in which neuroticism levels increased the most when compared to school leavers. Taken together, these findings suggest that the medical school environment seems to blur the boundaries between two totally different populations at baseline. We agree that the intensity and nature of medical training is very likely to result in personality change [27] and that it is also possible that the medical school context can elicit the 'dark-side' and 'bright-side' aspects of personality traits [28].

Some critical issues should be taken into consideration when interpreting the results of this study. First, we must acknowledge that it is a single-centre study, which could make it unclear as to whether these findings could be generalised to other settings. However, FMUP has had the highest access ratings for secondary school leavers in Portugal over the last decades, being the first medical school option for the majority of secondary school leavers. Furthermore, at least 12% of our graduate applicants are common to other three Portuguese medical schools that have different selection criteria for the graduate entry mode, whereby there is confidence that, at the very least, these findings can be extrapolated to Portugal. Another limitation is related with our participants' age. Although we have a sample comprised of graduates and

school leavers, personality traits change seems to be more robust in young adulthood (age 20–40)[24]. This means that it is not possible to separate what pertains only to a person's stage of life or to the medical school environment. The third limitation is concerned with assessments. The national examinations which form the previous achievement variable may have some variance on its difficulty per year. But more importantly, previous achievement was not assessed at the same time as personality traits. Whereas for most school leavers it was only a two-month time difference, for graduates, as previous achievement was built with national secondary examinations, it may have occurred years before. These years may have contributed to a difference in personality scores. Nevertheless, given that this was the selection criteria at the time, there was no possibility to circumvent this limitation. Moreover, we opted to present the data of the three cohorts measured as only one cohort because we had not enough sample power to study the effect stratified by cohort. Nevertheless, we must say that we did perform the sensitivity analysis and despite the lost sample power, we did confirm that results had the same trend. Finally, it may also have occurred that individuals faked self-report personality tests but as they completed the NEO-FFI after being admitted to the medical school, we assume participants answered honestly.

This study's major strength is its cross-lagged analysis that enables to investigate the causal relations between variables. Moreover, this study design allowed the conceptualization of personality traits also as outcomes in accordance with a dynamic perspective between the person and the situation. Unlike previous research, the personality variable was assessed twice and not only once. Also, our sample was comprised of two selected populations, which enables to study the influence of the medical environment on personality traits change. In addition, these cohorts continue to be followed and other psychological dimensions are being assessed.

In conclusion, this study confirms previous research on the association between previous achievement and medical academic achievement, the selection of different personality traits through different medical selection tools, and that graduates can widen psychological diversity among medical students. Nevertheless, it adds that some neuroticism may enhance medical academic achievement, reinforcing that all personality traits have simultaneously its bright and its dark-sides. Finally, the blurring of the initial differences between graduates and school leavers, suggests a reasonable possibility of personality traits change along the medical course. To support this finding, it would be valuable for this study to be replicated elsewhere. Medical students' selection process remains an unresolved challenge, but future research cannot afford to ignore the influence of the medical school environment on personality traits change.

Supporting information

S1 Dataset.
(CSV)

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Writing – original draft: Isabel Lourinho.

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CHAPTER VIII
Overall discussion

This thesis has concluded that in what concerns to personality assessment in the selection of medical students, we should privilege the use of different selection tools instead of only one tool. Results have shown that the use of explicit or implicit measures of personality is associated with which personality traits we aim to select, because different selection tools seem to select different personality traits. In this context, our studies displayed that if the goal is to select someone curious, intellectual, innovative, and flexible (high openness), we should adopt an implicit measure such as an admission interview (Paper II). This selection tool can also be used if we aim to choose someone who is simultaneously hard-working, responsible, organised and achievement-oriented (high conscientiousness), and sociable, talkative and energetic (high extraversion) (Paper II). If we value those who are helpful, cooperative and sympathetic (high agreeableness, shown to be associated with empathy on Paper III) we may use explicit measures of assessment such self-report personality tests (Paper I). This selection tool also allows to select those who are extraverted. Finally, if we want to select individuals who are not temperamental, not stress-prone, not anxious (low neuroticism), we may rely exclusively on an implicit measure such as previous achievement (Paper V).

Paper I has suggested that the graduates who participated in a medical school selection process have faked on some dimensions of the self-report personality tests (42). In the condition of applicants, they scored higher on conscientiousness and lower on neuroticism, but when already admitted as medical students, they scored higher on neuroticism but lower on the personality traits of conscientiousness and openness to experience. Past research had already shown that individuals can fake in line with the requirements of particular jobs (43, 44). It is possible that while applicants they considered the personality traits of agreeableness and extraversion as less evident for the ‘desired profile’ of a medical student and therefore, they may have been more honest in responding to the relevant items. Quite the opposite may have happened with the conscientiousness, openness and neuroticism traits, which were clearly identified as more important by the applicants. They could have felt that individuals who expressed these specific characteristics would be most likely to perform well either as medical students, either as clinical practitioners (44). Nevertheless, we must not forget that participants were asked to respond honestly and no

manipulated instructions were given. Moreover, they were informed that personality assessment would only be suitable for a characterization study and that their answers would not be accessible to the selection committee nor be taken into account for seriation. Thus, we believe that, if personality tests were part of the selection process, the faking differences between times of assessment would be even higher. This result carries implications for the selection of medical students because if medical schools select skilled applicants who are able to present a desirable/fake image on personality assessment, they will be in danger of admitting someone low in the future doctor-relevant traits (44). Furthermore, and accordingly with professionalism research, they may adopt negative behaviours as medical students and latter on in the condition of physicians (45). In summary, Paper I has shown some evidence that the incorporation of self-report personality tests in medical students' selection should be used in combination with other selection tools.

These results lead us to consider the use of implicit measures of personality assessment in medical students' selection. Historically, admission interviews have been considered one of the primary methods of assessing personal qualities (9). Studies evidenced that applicants and interviewers tend to view the interviewing process positively, with some applicants inclusively preferring to apply to medical schools that conduct interviews (3). However, until Paper II, there was no research about which personality traits (under the rubric of the FFM model) were associated with a higher score in a medical school admission interview. Associations had only been established with written tests and with MMI(46-48). With Paper II, we were able to observe that the personality traits selected for the admission interview were not the same that had been chosen by previous achievement (49). Also, and contrarily to what was found in MMI, to have a higher score at our admission interview, applicants had to score higher in the openness to experience trait and simultaneously in the consciousness and extraversion trait. For all that, Paper II reinforces that different selection medical tools call upon different personally traits. It is very likely that many medical schools that have adopted certain selection processes may ignore which personality traits are being chosen. Paper II also made us to reflect on the consequences of the amount of interaction time between applicants and interviewers or examiners. One must be aware that faking is not exclusive of self-

report tests, as it may occur in other implicit measures that require the presence of external evaluators. In fact, despite the general acceptance of MMI in the last few years, we have hypothesized that it may be easier to “fake good” (47) at an eight minutes interaction that than at thirty minutes, as it happened in our admission interview. Whereas for applicants thirty minutes may be more demanding and stressful, for interviewers/examiners it can be more helpful by providing a more holistic and genuine understanding of the applicants. Paper II has shown that the length of interaction may be one possible strategy to circumvent the faking effect. It is perhaps no coincidence that lengthening station duration had already been recommended for MMI (50, 51). Paper II also drew attention for gender issues. When the gender of the applicants was the opposite of the interviewers, they had a higher interview score. This finding shows the need to have more studies on the impact of gender on selection and on how to design assessment committees and improve methodologies that involve external evaluators such as interviews and MMI. Perhaps it would be better to have gender or sexual orientation equality among the total number of interviewers/examiners. However, this gender issue may extend beyond the selection moment considering the multiple evaluations, such as oral examinations or presentations, that usually happen along the medical course. Accordingly, some academic results may be over or underestimated due to students’ and professors’ gender. In addition, it would make complete sense that interviewers/examiners personality should also be assessed. It is our understanding that, since there is an encounter between two or more human beings, a bidirectional interaction occurs. However, until this moment, we ignore the existence of research that integrates both interviewer’s and interviewee’s personality assessment. In short, Paper II confirmed that an admission interview selects different personality traits when compared to those selected exclusively on previous achievement and with other existent selection tools. However, we must not ignore that this admission was not replicated elsewhere and that it is a time-consuming, complex and expensive method. As such, it seems important to investigate other implicit personality measures that besides being less susceptible to faking, may overcome the identified limitations. Recently, there has been interest in situational judgment tests (SJTs), which present realistic, job-related situations and ask participants to indicate what should be done to handle

each situation effectively (52). Due to their predictive validity and diversity benefits, SJTs have made inroads in medical education and selection (7), but so far, SJTs assessing implicit trait theories have not been adopted in medical education. In summary, it seems that, relatively to the selection of medical students, the solution may be to simultaneously have different selection tools in order to ensure a greater diversity and society's representability at the begging of the medical course. This is what already happens in the Netherlands (53, 54).

Regarding to our second general objective, this thesis has also led to the conclusion that personality traits are bidirectionaly associated with academic and non-academic outcomes in medical education. Paper III has confirmed the association between personality traits and empathy (55). Literature had already evidenced that empathy may be very important on clinical practice because, for example, it can enhance patient compliance (56) Although some studies have revealed that this personal characteristic seems to diminish along the medical course (57) successful interventions to increase medical students' levels of empathy have been designed (58). Paper III allowed us to establish that empathy may be assessed directly through the use of NEO-FFI. In addition, when compared to another study that used the Jefferson scale, our study that used the IRI instrument to assess empathy, showed a higher discrimination to predict top tercile of empathy (55). Additionally, when we assessed the correlations with each IRI sub-scales and NEO-FFI, we found positive associations between PD and neuroticism, EC and extraversion, and between PT and conscientiousness, contradicting the results of that study that only demonstrated associations with openness to experience and agreeableness. It is important to clearly underline that one of the major problems of research on psychological constructs such as personality or empathy relies on the existence of various different measures. And in most cases, instruments are designed under the umbrella of a specific theory that may have underpinned assumptions that are not the same. This may be one of the explanations for some of the contradictory results that have been found.
Anyway, it is universally known that physicians, when compared with other professional groups, are more prone to stress, depression and burnout (24). The workload, attending emergencies, the shift work, or the pressure to saving human lives are some of the main identified causes (59). But it seems that, as medical

students, they are also more vulnerable to psychopathology when compared with other groups of the same age (60). With Paper IV we were able to investigate the prevalence of anxiety and depression among medical students at FMUP. We had the opportunity to have a longitudinal and cross-sectional study. Results confirmed the existence of psychological distress, but also showed the existence of an association between personal characteristics such as obsessiveness-compulsiveness and self-concept on the worsening or improvement of the psychological conditions (61). This study gives rise to at least three considerations: first, that psychopathology does not only exist *per se* but it is associated with personal dimensions; second, that there seems to be a link between environment requirements and psychological conditions; third, that all together, this indicates that there is room to design specific targeted interventions. Some examples could be mindfulness applied to medical students or anxiety or time management courses for the students before examination periods (62-64).

Finally, the cross-lagged analysis at Paper V confirmed previous research but it also added new information. In particular, it confirmed that personality traits do associate with academic achievement. However, whilst the majority of research has found an association between the conscientiousness trait and academic success, Paper V found an association with neuroticism (40). This personality trait has been frequently mentioned to as a “bad trait”, mainly due to its association with negative outcomes such as distress. But very recently, some authors have highlighted that every personality trait has its “dark and bright” side, or according to the evolutionary theory of personality, its “costs and benefits” (19, 65). Indeed, Paper V has established the usefulness of being a bit neurotic in order to get good marks. In any case, we cannot ignore the results of Paper IV nor the neuroticism dark-side. Is it inevitable that the cost of being a successful medical student is having negative reactions to stress? In any case, these results were only possible due to a conceptualization of personality traits as outcomes and not solely as explanatory variables, as it happens in the vast majority of medical education research. Moreover, these results allow us to have a different conceptualization of personality traits on medical education outcomes as shown in Figure 2. Afther this thesis we have concluded that it is possible to use either implicit assessments either explicit assessments, depending of the personality traits we aim to select. Regarding to the association of personality traits on

medical education outcomes we have shown that it is bidirectional and not linear. Furthermore, their action has similar consequences on academic and on non-academic outcomes.

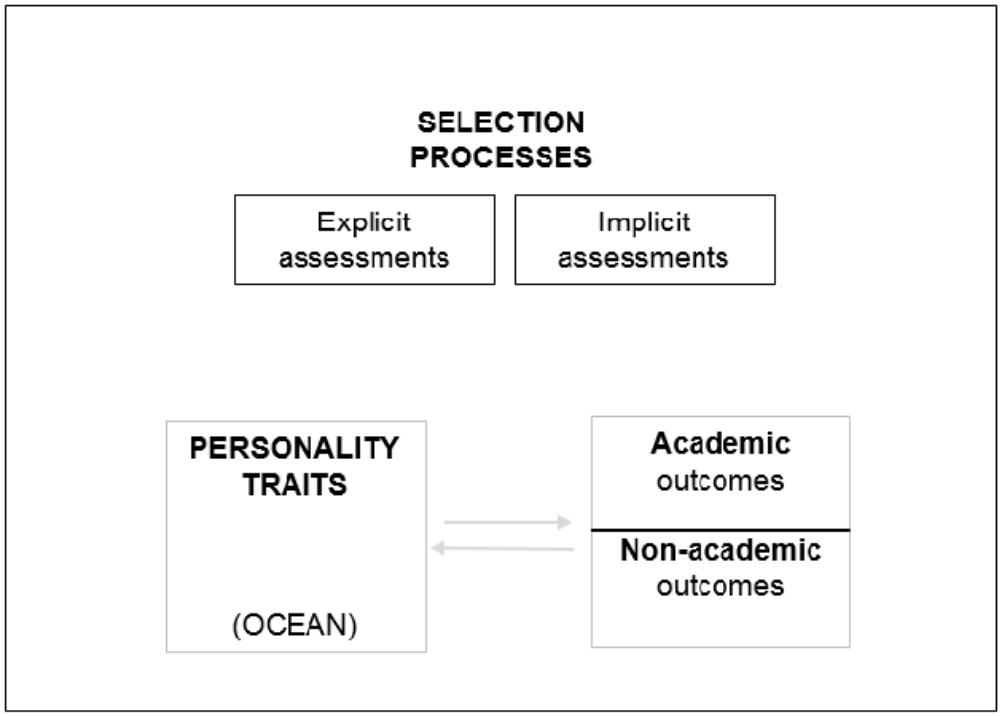

Figure 2. Global conceptualization of the influence of personality traits in medical education after this doctoral thesis.

Paper V has also allowed to confirm the psychological differences between school-leavers and graduates at the beginning of the medical course in a way that could be positive. This could be enough reason to corroborate that GEM is a complementary strategy to the inclusion of non-academic characteristics in widening access to medical education. However, it turned out that, later on the medical course, graduates and school-leavers became more similar relatively to personality traits. Graduates increased their neuroticism scores and their academic achievement. This calls upon two major issues/reflections. On one hand, what is the point of selecting based on a specific personality trait if a) traits change along the medical course; b) every trait has its bright and its dark side which are expressed at different times? On the other hand, the psychological diversity brought by the graduate population seems to be attenuated/minimized along the medical course. It also puts into question those that argue that graduates' most important advantage was the age factor instead of their previous

academic experience (35) . Therefore, the psychological diversity that they could add does not apply. Piele argued that graduates would only add value to medical schools if they had a specific medical programme that could optimize their past experiences (33). However, FMUP's graduate students have to attend the same undergraduate entry curricula that school-leavers do.

Another important point we want to highlight is that a successful medical student will not be necessarily be a competent and/or happy/healthy doctor. However, this raises at least two other problems, namely the inexistence of a consensual definition of what is a good doctor and, above all, how to measure this construct. All together, results suggest that the selection moment seems to be not so determinant, and that the medical context environment becomes more relevant. Paper IV and Paper V have both shown the influence of the medical context on personality traits, which in turn are associated with different outcomes. The medical school setting is comprised of the formal and the hidden curriculum but also of the existent role models. We shall not forget that medical students' beliefs, behaviours and professional values are mostly shaped through the interaction with their professors, physicians or not, and fellow students (26). This may be good news since, instead of a one single moment (selection), there seems to be several opportunities to design and implement targeted interventions (along the medical course).

The main limitation of this research is being a single-centre study, which could make unclear as to whether these findings could be generalised to other settings. However, FMUP has had the highest access ratings for secondary school leavers in Portugal over the last decades, being the first medical school option for the majority of secondary school leavers. Furthermore, at least 12% of our graduate applicants are common to other three Portuguese medical schools that have different selection criteria for the graduate entry mode, whereby there is confidence that, at the very least, these findings can be extrapolated to Portugal (40). Either way, we believe that personality assessment may be a useful tool by allowing at least the identification of those who will benefit the most from addressed interventions. It may be necessary to regard personality change and management as a part of medical education as well as selection. Future research on the impact of personality interventions in the medical school environment is required.

CHAPTER IX
Concluding remarks and future perspectives

This thesis aimed to contribute to the covering of a gap in the literature of medical education in respect to the role of personality traits. Our studies allowed us to establish a birectional association between personality traits and different medical education outcomes such as the score at an admission interview, empathy levels or academic achievement along the medical course. It was also observed that psychopathology does exist at the medical school and it is associated with personal constructs. These results could support the use of personality assessment in medical students' selection. However, the adoption of a medical selection tool is associated with which personality traits we want to choose. The solution may be to simultaneously have different selection tools, in order to ensure a greater diversity and society's representability at the begging of the medical course.

We have also presented evidence that medical education research can no longer conceptualize personality traits as deterministic and stable over time. The blurring of the initial differences between school-leavers and graduates along the medical course suggests the influence of the medical school environment on personality traits change. By assuming a transactional interaction between personality traits and environment, it was possible to determine that a "bad trait" such as neuroticism also has its bright side, since it can enable medical academic achievement. Thus, taking all the results together, whether or not the environment narrows heterogeneity, we could question the usefulness of strategies that aim at widening access to medical education (e.g. broadening admission requirements in relation to non-academic personal characteristics and the GEM approach). It seems that apart from the selection single moment, education and training may be powerful implements in promoting effective change. This may be good news because there are several opportunities to design and implement targeted interventions (along the medical course). Furthermore, it could be advantageous that graduates had a specific curriculum taking into account their specificities, instead of sharing the same of school-leavers.

Further studies must assume a transactional relation between medical school environment and personality traits and should assess: a) main determinants of the environment that may lead to personality trait change; b) if this change is exclusive of this medical school or if it also happens in other medical schools or other courses; and c) the impact of personality interventions on the medical

school environment. After all, each setting has its idiosyncrasies. Also, we cannot forget that applicants also make their own selection (46). Nevertheless, this population continues to be followed in these and other psychological dimensions in order to investigate whether changes continue along their lifespan.

CHAPTER X
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